SUBSCRIPTION RATES:

The Annual Subscription, post free, to any part of the world is 21/- (English) or its equivalent in other currency. The price of single copies is 1/6, or 1/9 if sent by post. Back numbers (when available) are charged double if over six months old.

CONTRIBUTIONS:

All Letters and Contributions intended for Publication should be addressed to:—
K. R. DOGGETT, Editor,
"The Dock and Harbour Authority,"
19, Harcourt Street, London, W.1.
Telephone: PADdington 0077/8.

The Dock & Harbour Authority

No. 314. Vol. XXVII. DECEMBER, 1946

CONTENTS

Editorial Comments

Military Ports in Peace-Time.

There is necessarily so profound a difference in character and function between military ports and commercial ports, that, generally speaking, the former lie outside the purview of this Journal, but, occasionally, there are features of design and construction which justify some notice, as affording information of importance on matters of common interest. For this reason we have seen fit in the present issue to include an article by Mr. P. Steer descriptive of the creation during the recent war of the two military ports in South Scotland; No. 1 in Faslane Bay on the Gareloch at the entrance of the River Clyde and No. 2 at Cairn Ryan on the east side of Loch Ryan.

The considerations which lead to the establishment of military ports, indeed, are fundamentally remote from and incompatible with those governing commercial ports. In the former case, the object is purely military and strategical and the question of location quite independent of commercial interests. Thus the two ports described in the article have been created in situations which are not altogether favourably adapted for commercial exploitation, there being no manufacturing or urban environment and no association with any established trading route. Moreover, circumstances required them to be constructed with great rapidity, using material and equipment readily available under the most rigorous secrecy obtainable.

Now that their war-time purpose has been served, their "occupation," like Othello's, "is gone." Though one of them is close to the great seaport of Glasgow, this proximity confers little or no advantage on either. Indeed, in certain circumstances which could conceivably arise, it might lead to what might be described as undesirable and futile competition. As a matter of fact, as stated in Mr. Steer's article, Faslane Harbour has been relegated to the subordinate position of a depot for marine salvage, towage, and ship-breaking. What the future may have in store for Cairn Ryan we cannot say, but being remote from the main traffic routes by land or sea, it is little likely to fare any better than its sister port.

To avoid the possibility of detriment to the interests of the Port of Glasgow, the Ministry of War Transport on 20th January, 1942, gave the Clyde Navigation Trust a written assurance that if at any time after the war the Government should decide to discontinue using the Port of Faslane for war material handled by military personnel, they would not dispose of the facilities there to any undertaking other than the Trust without consultation and agreement with them.

The matter was the subject of comment in the Report of the Clyde Estuary Committee as published in our issue of January last. The Committee then considered that the two ports under review could not be converted under peace-time conditions into economic commercial undertakings, a conclusion which the circumstances rendered almost inevitable.

Pilferage at Ports.

Of late, the incidence of pilferage and theft of goods in transit has once more assumed alarming proportions at a number of ports throughout the world, and in many countries steps are being intensified to counteract an evil to which we have alluded on several occasions in the past.

It is stated in the American press that at some ports in the U.S.A., the value of goods stolen runs into millions of dollars annually, and maritime interests there are co-operating with exporters in an endeavour to prevent losses which are damaging the prestige of American shipping companies.

Recently, the New York Board of Trade, following a discussion of the problem with shipping representatives, agreed to support a concerted attempt to stamp out the evil at the Port of New York. They are also seeking the aid of the State Department to change certain practices in foreign countries which, owing to lack of control and supervision, invite large scale thefts of consignments.

Unfortunately, pilferage is equally prevalent in this country, and the extent of the evil was referred to by Mr. I. Jones-Parry, a director of Lloyds Packing Warehouses, Ltd., Manchester, when he recently addressed the Liverpool branch of the Institute of Export. Mr. Jones-Parry expressed the view that the thieves in some cases must have access to consignment notes or other documents, and said the packer took every precaution by independent counting and weighing to ensure that the contents were correct when packages left the warehouses, but losses occurred in transit to the port, on the docks at both ends of the voyage and also while the packages were in the ship's hold. Often the entire contents of cases were replaced by old newspapers to delay discovery, indicating that the sea journey gave the most time and opportunity for the thefts. Various devices were used by packers to foil the thieves, but unfortunately, such devices also served to indicate that a case contained valuable materials. Mr. Jones-Parry emphasised that there was room for more careful examination abroad to detect the evidence of pilferage before the package is opened, as all too often, the shortage is not discovered until afterwards, when the evidence has been destroyed.

There is little doubt that a great deal of pilferage is due to the unsatisfactory manner in which shippers pack their goods, and commodities of relatively low value are often more carefully cased than more expensive items. At the same time, as most

Editorial Comments – continued

packages are plainly marked with their contents, the thieves are able to select only those they consider worth attention.

Many suggestions to help suppress pilfering have been advanced from different quarters and among them is the pertinent one that the contents of the packages should not be stated on the outside, but that code letters or numbers should be substituted. Another suggestion, that shippers of badly-packed goods should pay a higher insurance rate, is, in our view, impracticable.

It is obvious that the present state of affairs cannot be allowed to continue, and any plans which are formulated to combat the evil, will be welcomed by insurance companies as also by port and shipping interests on whom rests the ultimate responsibility for the safe transit of goods by sea.

The British Free Port Question.

The decision of the British Government in regard to the establishment of a Free Port area within the confines of the United Kingdom, as expressed recently in the House of Commons by Mr. W. G. Hall, the Financial Secretary to the Treasury, should set at rest, once and for all, the agitation on the matter which has been going on in the public press for some time. Mr. Hall was replying to a question put by Mr. Peter Freeman, the member for Newport (Mon.) who was mainly actuated by a desire to benefit the South Wales ports "in view of their convenient situation," though, at the same time, he advanced the view generally that a free port was a means of "augmenting trade and industry."

It was in this general sense that the proposal was considered by expert officials of the Board of Trade and the Ministry of Transport, and after weighing all the arguments in its favour they have come to the conclusion that a free port system offers no advantage over the existing Customs facilities available at British ports and would not assist either the national foreign trade or internal industrial development.

To those who are acquainted with the Customs facilities in question and the scope for dealing with re-exports by means of Bonded Warehouses, which are in existence at the leading ports of the country, the decision can cause no surprise. The agitation has been due to a misconception by the public of the practicable functions of what is termed a "Free Port," or in the United States, a "Foreign Trade Zone." In the popular view, it has been endowed with idealistic possibilities of creating new commercial activities which are either not realisable, or not more feasible than under existing conditions in Great Britain. The examples adduced from the Continent of Europe, Hamburg, Copenhagen and the like, as also the isolated case of New York in the United States, do not provide analogies sufficiently convincing to justify a departure from existing practice. Free Trade areas are not a panacea for the creation of overseas trade, though they may provide in suitable circumstances and in certain respects, favourable conditions for its development. Considered as a remedy for the depressed industrial conditions in South Wales, they would prove entirely illusory and disappointing.

Beach Preservation in the United States.

In the New York *Herald Tribune* of 15th September last an account is given of recent researches and impending investigations by the Beach Erosion Board of the U.S. Army Engineers Corps. Great progress is claimed to have been made during the war on the charting of off-shore underwater areas and the laboratory models which were constructed and operated, assisted in the planning of invasion landings. The Board developed aerial photographic analysis methods for determining the depth of off-shore areas within a matter of inches from altitudes of 6 miles and rendered it possible to distinguish whether objects under the water were seaweed beds, coral reefs, sand bars or other formations, and also to ascertain the depth of water over such obstructions.

From its pre-war peace-time studies, during which it was established that there existed a statistical relation between the diameter of beach sands and the slope of the foreshore beach, it was found possible to predict the slope of an invasion beach from samples of the sand of which it was composed. In the Washington wave tank model studies were made for the artificial breakwaters of sunken ships used for the Normandy landings.

Before the North African and Sicily invasions, Dr. H. U. Sverdrup and Mr. W. H. Munk at the Scripps Institution of Oceanography associated with the University of California, developed a method of forecasting the height, period and arrival time of wind-waves and swells by interpretation of weather maps. This method can now be used by engineers engaged on structures exposed to wave action, permitting them to arrange their work for the following day on the basis of the type of wave action to be expected.

Last year, President Truman signed a Bill sponsored by the American Shore and Beach Preservation Association, Newark, New Jersey, under which the Beach Erosion Board will now undertake to make broad scientific studies of means for arresting beach erosion which is its original peace time purpose.

Commenting on the problems to be faced Dr. Martin A. Mason, chief engineer of the Board, outlined the major task as follows:

"Stated simply, there are just two main elements concerned in beach processes: the material and the energy. A stable beach is one in which the material coming in and going out exactly balance; the beach does not change—it may move, but there is no net loss or gain of material. One of the first things we are going to do in attempting to solve the problem of material-energy balance is to examine the material side of the picture and, if we can, determine not only the characteristics of the materials, what materials compose beaches and how these materials behave, but also endeavour to find where they come from and where they go."

The Institute of Transport and Port Operation.

As is well known, owing to the prevailing shortage of paper, text books are practically unobtainable, so that students are seriously handicapped by the lack of up-to-date material to assist them in their studies. Some members of the Institute of Transport have therefore approached us to see whether we could assist them by providing information on methods of Port Operation, and after consultation with a number of port officials, we have agreed the time is opportune for a series of articles on this subject.

Accordingly, we have invited Mr. A. H. J. Bown, M.Inst.T., A.C.I.S., General Manager to the River Wear Commissioners and General Manager of Sunderland Corporation Quay, and Lt.-Col. C. A. Dove, M.B.E., M.Inst.T., late Embarkation Commandant, Calcutta, to collaborate in writing twelve monthly articles, and have arranged that the first of these will appear in our January issue.

As already indicated, the series is intended primarily for students, and will therefore follow the syllabus laid down by the Institute of Transport for their Associate Membership examination, but at the same time, the information contained in the articles should be of value to a far wider field of readers, and will, we trust, prove helpful to those more experienced in port management and operation.

Methods of port operation are naturally varied according to the physical conditions and commercial usages obtaining at different ports. These divergences may be purely local, or they may be so widespread as to become even national in character. In Europe, the quay crane is a typical feature; in North America, it is displaced by the system known as Burtoning. Many other instances might be given. For such reasons we would welcome the criticisms and comments of our readers, and for these, our correspondence columns are freely open.

Dock Labour Decasualisation.

With reference to previous Editorial Comments dealing with the need for a satisfactory scheme for the decasualisation of dock labour, it is interesting to observe that difficulties connected with a redundancy of labour at ports are not confined to this country only, and reports have been received that other maritime nations are confronted with a similar problem. In particular, it is stated that the regulations contemplated in Great Britain are being considered with much interest by French circles, and at a recent meeting the Association des Grands Ports Français heard a full review of the matter by a chief engineer of the Public Works administration. The point of interest for the time being, is the extent to which the war-time system which was adopted in Great Britain, will be retained as part of the permanent scheme which is in course of preparation by the Minister of Labour.

The Military Ports of Faslane and Cairn Ryan

Description of Two Notable War-time Installations

By P. B. STEER, A.M.I.C.E., A.M.I.Struct.E.

Introduction

THE recent acquisition of No. 1 Military Port of Faslane on the Gareloch by Metal Industries, Ltd., for the business of large-scale marine salvage, towage, and shipbreaking serves to draw attention once more to these two important ports built entirely by military labour during the war. The story of how these ports were built in the face of innumerable difficulties and under conditions differing widely from the normal, will be interesting to civil engineers engaged in dock and harbour undertakings.

During the grim days of May and June, 1940, when we staged the epic of Dunkirk, and France fell to the apparently all-conquering Nazis, the position of our small island looked very serious. The ports on the East and South Coasts were now virtually closed to large ocean-going ships, and the great Port of London became a priority target for the Luftwaffe bombers.

Imports had to be maintained and even increased, especially materials of war from the U.S.A., and in addition, the War Department was looking ahead and seeking deep-water berths for its export traffic.

A reconnaissance of existing facilities in the West Coast ports showed that they were unable to cope with additional military traffic, and if there were losses from enemy action the position would deteriorate. The military vessels at present using commercial docks were taking up quay space and not using the transit facilities available for import traffic, for most of the military goods were for export.

The solution appeared to be the construction of new deep-water berths by the War Department, but it was recognised that this would only provide part of the facilities required in the first year and the whole in the second year, because the construction of a port is a major engineering work even in peace-time, and in war-time would have the disadvantages of shortages of men and materials and interference from enemy action.

After some deliberation the War Department decided to investigate probable sites, and it was found that one in the Gareloch off the Clyde and the other in Loch Ryan, Wigtownshire, would fulfil the requirements. The plan was to build deep-water wharves providing for 12 ships up to 500-ft. long and drawing 30-ft., and with lighterage wharves, railways, roads, and all the necessary port facilities. The main items of shipment would be general stores, ammunition, cased petrol and motor transport. Sufficient cranage would be required for loading direct from rail or road or lighters. The necessary holding sidings would be required for two days' traffic. The port was to be built for war service only, and therefore features normally adopted for long life were to be excluded to speed construction.

By November, 1940, the position regarding deep-water berths had worsened, and it was deemed advisable to push ahead with all speed the provision of lighterage and three deep-water berths at each of the sites at the Gareloch and Loch Ryan, so that:—

(a) facilities could be developed at the earliest possible moment;
(b) risk of delays due to engineering difficulties might be lessened by building at two sites;
(c) risk of damage by enemy action reduced.

There would be the added advantage that whilst the immediate requirements for additional berths could be met by developing both sites, on the completion of preliminary works, one or both sites could be expeditiously developed still further, to meet any further need for berths.

(This decision to build at two sites was a wise one, for one site did prove to be more difficult than the other).

Accordingly arrangements were made to go ahead with work at Faslane Bay in the Gareloch and in Loch Ryan, in two stages, i.e.,

Stage 1.—Lighterage wharf 900-ft. long and all ancillary railway works to provide at an early date lighterage to vessels moored in the Loch in deep water.

Stage 2—Simultaneously with Stage 1, a deep-water quay of length for three berths to be constructed. A further three berths to be allowed for in the design. Total possible length, 3,000-ft.

It was also decided to carry out the whole scheme by military labour, and as the two sites were removed from towns, camps and all the necessary amenities had to be planned for about 2,000 men at each site.

No. 1 Military Port—The Lighterage Wharf.

No military organisation existed in 1940 for the design and construction of two such ports, and from a small beginning a large staff of technical officers, assisted by civilian engineers, all experienced in dock and harbour work, had to be hurriedly brought together within the framework of the War Office to put in hand the design, work out the multitude of details, and obtain the required plant and materials. The question of the military labour on site was a complex one, for no specialised companies in port construction then existed, and it was necessary to commence the work with existing General Construction Companies of the Corps of Royal Engineers, ably assisted by the Pioneer Corps.

Work was begun on both sites in December, 1940, under the direction of the Transportation Department at the War Office (known as " Tn ") and it was soon realised that this large undertaking in addition to all the other commitments of war would require immense patience and skill to bring it to a successful completion in the desired time.

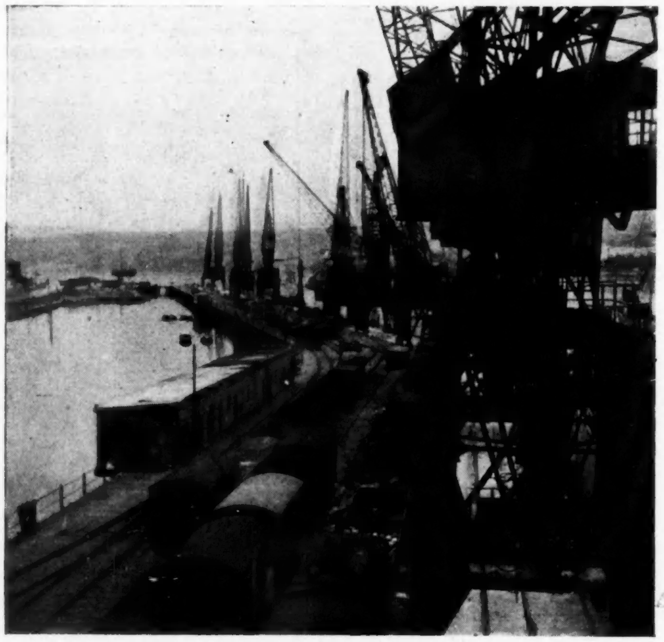
No. 1 MILITARY PORT (FASLANE)

The port in the Gareloch, formerly known as No. 1 Military Port, is situated in Faslane Bay (see Plan 1) on the eastern side of the north end of the Loch. The approach railway joins

Military Ports of Faslane and Cairn Ryan—continued

the L.N.E.R. (West Highland Line), about 1½ miles on the Helensburgh side of Shandon Railway Station. The exchange sidings are close to this junction, and the main sidings are at the rear of the Lighterage Wharf. Altogether, some 22 miles of tracks were laid with two bridges and two level crossings. The tidal range at Springs is 11.6-ft.

The Lighterage Wharf is an ordinary timber-piled structure 31-ft. wide, 900-ft. long, and there is 1½ fathoms of water alongside at M.L.W.S. The wharf is equipped with 30-cwt. portal electric cranes. No difficulties were experienced in the construction, and on embankments tipped out at each end, derricks were erected and piles driven working toward each other across the bay to meet at the centre. At the same time rock-filling was tipped from side-tipping wagons running on the wharf and the pre-cast concrete slabs built on top to the required level. Filling at the back was placed by Le Tournai scrapers moving earth from the adjacent area scheduled for use as sidings. Concrete pipes were used as culverts to carry away two streams under the filling.



No. 1 Military Port—The Deep-water Wharf, looking South.

Joining this wharf to the deep-water wharf is the Mechanical Transport Wharf—a sheet-piled wall with 1½ fathoms of water, at Mean Low Water Springs.

The Deep-Water Wharf is about 75-ft. wide and 3,000-ft. long, providing six deep-water berths for ships drawing 30-ft. Five rail tracks served the berths, and the wharf is equipped with 2, 5 and 10-ton electric cranes. The heavy loads under the cranes are carried by concrete beams on cylinders, and the remainder is an ordinary piled structure. Interesting features were the use of screwcrete cylinders and composite piles. From the results of the borings and test piles, it was anticipated that the screwcrete cylinders would screw down to the rock and safely carry the load of 150 tons, and that the composite piles would reach the desired set for a safe load of 40 tons.

The plan of operations was carefully worked out to avoid any delays and a pile yard laid out and means provided to supply the necessary piles, timber decking, bracing, cylinder reinforcing cages, pre-cast concrete, beams and slabs, as and when required.

For a time the screwing proceeded according to expectation, but subsequently insufficient penetration was obtained and different screw points were tried without success. It was ultimately decided to adopt a footing for some cylinders which were not considered able to penetrate the ground for sufficient depth by screwing. The 14-in. x 14-in. composite piles were made up of the lower portion in reinforced concrete and the upper 20-ft. in timber spliced by 2—14 x ½ mild steel plates 8-ft. long, and driven complete.

These were used to conserve the supplies of timber which were very short and still maintain a timber superstructure for ease in construction.

To equip the wharf with cranes at the earliest possible moment it was decided to obtain cranes on loan from the Ports of London and Southampton, and the latter port also loaned a 150-ton floating crane which proved extremely useful during the construction of the port. The work of preparing for towing this huge crane and the installation at Faslane was successfully carried out by military labour.

A special berth was constructed 500-ft. long and with 1½ fathoms alongside at the South end of the port and for this 150-ton floating crane and other small craft. This berth is connected to the deep-water wharf by a bridge over a barge cutting, the latter to enable barges to use the back of the wharf. A railway track passes over the bridge from the deep-water wharf to a shunting neck at the extreme South end of the crane berth and together with a track running alongside the main road enables the the whole of the wharves to be included in a rail circuit which would have been invaluable had the port suffered from enemy action.

So that the first three berths and the second three berths of the deep-water wharf could be served independently, separate siding connections were provided.

To overcome certain disabilities at Faslane Bay, right-hand running of the railway was instituted over the running lines between the Junction and Faslane Bay. The railway gradient on the approach line was 1 in 49 and the minimum radius of curves was 5 chains.

Dredging Operations

The main item of dredging for the port was that done at Rhu Point at the entrance to the Loch. This entrance was deepened to 30-ft. below Chart Datum over a width of 400-ft. Part of this dredged material was ballast and was used for filling behind the 150-ton floating crane berth by pumping.

In addition a certain amount of dredging had to be done along the face of the deep-water wharves, lighterage wharf and Mechanical Transport Wharf.

About 200,000 cub. yds. of dredging was carried out in all—75% being from Rhu Point. Bucket dredgers and self-propelled and dumb hopper barges were used throughout.

To provide speedy construction, standard army sheds were used for the transit schemes, machine shops, loco. sheds, etc. These sheds are 36-ft. 6-in. span and can be quickly erected to any length and in multiple spans. The large house known as *Belmore* was requisitioned and used in the first instance as headquarters for the Commander Royal Engineers and his staff, later becoming offices for the Port Superintendent.

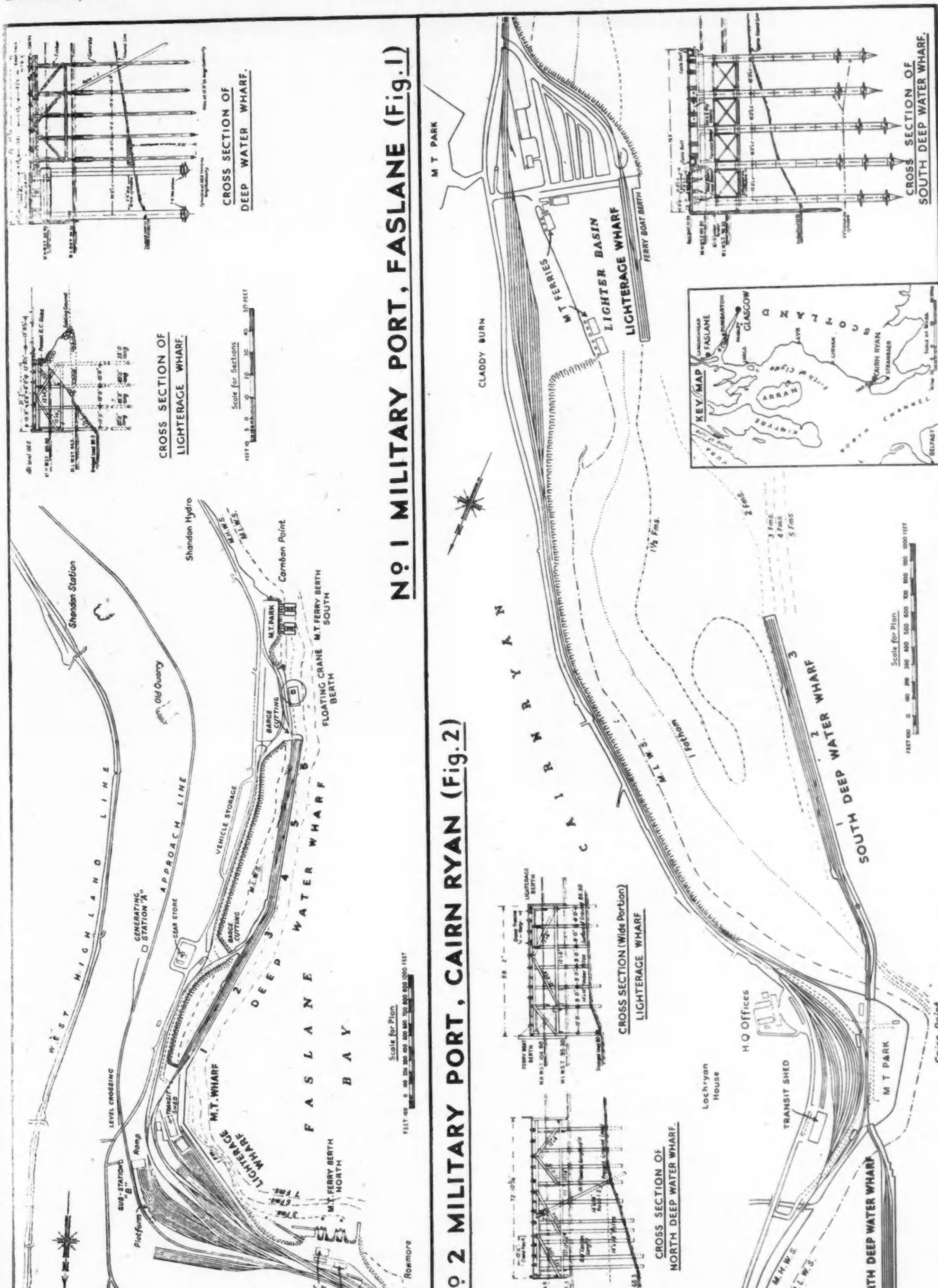
Road Diversion

It was obvious in the early stages that the road from Helensburgh to Garelochhead would have to be diverted for 1¾ miles, and after many discussions with the Ministry of Transport Roads Division, it was agreed that the rigid specification normally laid down could be modified, in so far as temporary bridges, footpaths, concrete kerbing, etc., were concerned, in view of the fact that the road diversion was to be designed on a temporary basis.

If the road was to be retained after the war on a permanent basis, the standard could be raised.

This new road involved two bridges and a level crossing. The general specification of the road diversion was that it should be 18-ft. wide, with one footpath 5-ft. wide, except on the bridge. The carriageway to be provided with 8-in. of bottoming, laid in two layers, the bottom layer being 6-in. of broken stone, and the top 2-in. in depth. Traffic to be run over for consolidation, and then 3-in. of tarmacadam applied.

The road inside the port area was a similar specification, and commencing at the junction with the main road at the northern extremity, continued inside the port by way of the Lighter Wharf sidings, Mechanical Transport Wharf, and thence along an embankment adjoining the main road to the south end of the port.



No. 1 MILITARY PORT, FASLANE (Fig. 1)

No. 2 MILITARY PORT, CAIRN RYAN (Fig. 2)

Military Ports of Faslane and Cairn Ryan—continued

Electric Plant Installation

Owing to the limited supply of electricity from the local authority it was decided to provide generating plant to deal with part of the requirements, difficult though the position was to obtain suitable plant. The most important load was the cranes equipped with D.C. motors totalling approximately 2,600 h.p.

For security reasons the plant—a D.C. power system fed from independent Diesel plant—was installed in two generating stations and designed for maximum flexibility of operation and for ease of repair.

Low visibility marker lights were provided at intervals of 50-ft. along the bank of the deep-water wharf to assist personnel on a dark night in the event of normal lighting being off during air raids.

No. 2 MILITARY PORT (CAIRN RYAN)

No. 2 Military Port is at Cairn Ryan on the eastern side of Loch Ryan, 6 miles north of Stranaer. (See Plan 2). The connection to the L.M.S. Railway is 6 miles long, with exchange sidings and three set of sorting sidings, totalling some 28 miles of railway track. Although the approach line is rather long and necessitated two bridges over main roads, there were few engineering difficulties. The large exchange sidings are due to the fact that there are no holding sidings on the main line within a reasonable distance.

The borings and survey revealed that the ground was very soft along the proposed line of the deep-water wharf south of Cairn Point and when a test pile was driven it penetrated 87-ft. without any satisfactory set being obtained. This led to the adoption of a design for the deep water wharf south consisting of four berths totalling 2,000-ft. in screw cylinders throughout.

The ground at the proposed Lighter Wharf offered a better resistance to a driven pile and an ordinary piled structure was decided upon which would run north from reclaimed land and enclose a basin, the inner face of the wharf being for lighterage and the outer face for a ferry boat berth and other craft drawing 15-ft.

To provide the fifth deep-water berth it was decided to built out from the north side of Cairn Point and although the bearing capacity of the soil was again poor, a design was worked out using composite piles at close centres for the loads under the cranes.

The tidal range at Springs is 9.3-ft.

Lighterage Wharf.—The wharf is 900-ft. long and built of 14-in. x 14-in. timber piles capping, and 12-in. x 6-in. timber bracing; 30-cwt., 2-ton, and 3-ton cranes are provided and owing to the fact that the cranes were on loan from different ports, two gauges of crane track were required. The inner face of the wharf has 9-ft. of water and the outer face 15-ft. of water at Mean Low Water Springs. The south side of the basin is a steel sheet pile wall anchored back and providing 9-ft. of water at Mean Low Water Springs. This wall also forms one side of the triangular area of reclaimed land.

A 5-ton crane runs along this south quay and is supported on a line of reinforced concrete piles and beams for the seaward leg and a beam founded on the filling was considered able to carry the landward leg without undue settlement.

The whole of the triangular area was subsequently filled by pumping dredged materials and when sufficiently settled tarmac roads were laid to serve the area now laid out as a parking place.

South Deep Water Wharf.—The position of this wharf received very careful study and two main schemes were considered:

(1) that the wharf should be built with an approach from Claddy Burn, and

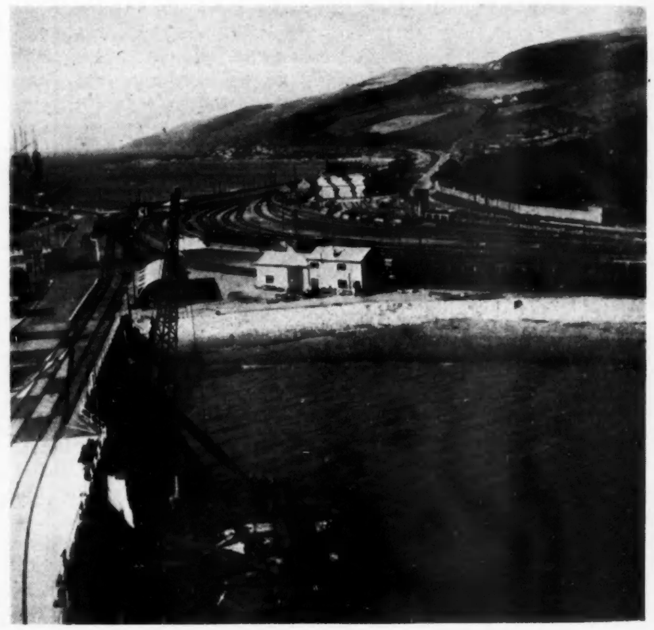
(2) that the approach should be from Cairn Point.

Scheme (1) gave a shorter rail connection and no back shunt but had many disadvantages, such as a very long approach (1,000-ft.); extensive filling at Claddy Burn and a heavy programme of dredging.

On the other hand, Scheme (2) enabled a short approach to the wharf, speedy commencement of work on the main portion of the wharf and little dredging, although the running of the railway connections to Cairn Point necessitated sea protection works for the formation, for a length of about three-quarters-of-a-mile along the foreshore.

Scheme (2) was therefore adopted and work commenced early in 1941.

The wharf is 73-ft. wide and has 33-ft. of water alongside at Mean Low Water Springs. The construction is entirely of reinforced concrete beams and slabs on cylinders. Five rail tracks and 6-ton and 3-ton electric cranes serve three of the berths, whilst the first berth from the approach has a 60-ton crane for heavy lifts.



No. 2 Military Port—The sidings at Cairn Point, with the approach to the deep-water wharf South in the foreground and the North deep-water wharf in the background.

For the construction of the wharf two screwing machines were erected, but progress was slow owing to unfavourable weather conditions. The rate of screwing gradually reached two cylinders per day working a shift of 24 hours. This rate was later improved by the use of an electric capstan worked from a derrick on a barge.

The total length of each cylinder was about 90-ft. made up of 9-ft. cast-iron sections bolted together with $1\frac{1}{4}$-in. diameter turned bolts through internal flanges. Later some cylinders were made of welded mild steel.

For pre-cast concrete deck a beam and slab casting yard was laid down at the Old House Point and a jetty built out for transporting the beams, etc., to the wharf. Weather conditions proved unsuitable for regular loadings so that ultimately a railway track was used almost entirely for the purpose.

The North Deep-Water Wharf was sited at the north side of Cairn Point and provides one deep-water berth with 5 fathoms of water at Mean Low Water Springs. The face line of the wharf ran approximately on the 3 fathoms contour, thus necessitating a certain amount of dredging. The section of the wharf is made up of 14-in. x 14-in. composite piles with 14-in. x 14-in. timber caps and bearers, and 12-in. x 6-in. timber decking. The whole is braced and raking piles were provided in addition.

The bents were nominally at 10-ft. centres, but extra piles were driven to support the crane loads, and in other places where resistance to driving was insufficient. The wharf carries five lines of railway tracks, and is equipped with three 3-ton electric electric cranes at 60-ft. radius, and two 6-ton electric cranes at 65-ft. radius.

Military Ports of Faslane and Cairn Ryan—continued

The space between the rails was filled in with 2-in. thick timber "flatting," and longitudinal wedge pieces adjacent to the rails to facilitate the movement of motor transport.

A ring water main runs completely round the face of the wharf and the electric supply is carried underneath the deck.

A short bank followed by a timber-piled structure forms the approach and no real difficulties were experienced in the construction.

The exposed position of this wharf was such that it suffered heavy buffeting from ships when the Atlantic Send was experienced, together with storms from the west and north-west. The wharf stood this well, however, but fenders had to be renewed from time to time.

Although the ground is poor and the cranes have been heavily worked, no subsidence has been observed in the structure.

The end of the wharf is rounded to present a fender in the event of a ship striking the corner.

Dredging

In addition to the dredging alongside the wharves, which amounted to about 250,000 cub. yds., it was decided to widen and deepen to 5 fathoms depth below Mean Low Water Springs the channel opposite the Deep-water wharf south and Lighterage Wharf, for a length of 1½ miles, to provide ample turning space and mooring area for three large vessels. This dredging totalled 300,000 cub. yds. of material.

To widen the entrance channel to Loch Ryan to 500-ft. and to provide 24-ft. depth at Mean Low Water Springs, it was necessary to take the top off one or two high spots with a bucket dredger.

Most of the remaining dredging was done by the *Victor Guilleaux*, a suction dredger manned by the Free French.

To provide a workshop area for repair of plant and machinery an old ship yard at Innermessan, complete with works and offices, was taken over and additions made. A jetty of timber piles was constructed and a slipway with cradle was built alongside capable of hauling up small tugs and barges for repair and overhaul. The slip was so made that the barges could be hauled out of the water and side-slipped to keep the slipway in use.

There were many difficulties to be overcome in the construction of these ports. All ranks were keen, but the lack of ready-made organisation, complete with the necessary skilled personnel to undertake work of this magnitude, acted as a handicap which was only overcome by the untiring energy and drive of the officers and men.

The chief function of an army is to wage war, and this is the prime factor in its build-up. The personnel must therefore have a maximum of military training consistent with the other duties allotted to it. The personnel must also be large in numbers to allow for this training if the work on a contract of this magnitude is to make the desired progress.

Nevertheless the work was pushed ahead, and as the men became more experienced and the organisation grew in efficiency, progress became more marked.

Many engineering problems had to be solved, both in actual construction and in the provision and handling of the materials. The founding of marine structures is always a tricky problem, and needs the application of many years' experience. At No. 1 Military Port the design of the deep-water berth had to be revised to suit the ground as work proceeded, whilst at No. 2 Military Port considerable depths of soft mud were found, and a special design of multiple screw cylinder had to be adopted. The weather, too, interfered with progress in Loch Ryan, and one gale did much damage to construction plant.

Local materials were used wherever possible, and quarries were developed to provide stone and aggregate.

The provision of good accommodation with the necessary amenities for the men was absolutely essential for the satisfactory progress of the work, and quarters had to be found for a total of 4,000 men on each side when operating personnel joined the construction companies. In the haste to commence work tents had to be used in the first instance, but these gave way to Nissen huts at the first opportunity. The water supply was inadequate, and had to be increased. At No. 2 Military Port a dam was finally constructed across Glen Burn, providing a reservoir capable of holding 1½ million gallons of water, which is passed through a purification and filter plant, and is now the chief source of supply to the port, camps and Cairn Ryan village.

The deep-water berths were first used at No. 1 Military Port in July, 1942, but it was not until the following year that the deep-water berths at No. 2 Military Port became available, owing to constructional difficulties.

The ports, with their railways, lighters, tugs, cranes, etc., were operated entirely by military personnel, and large quantities of military stores and equipment of all types have been loaded for the Allied Armies. From time to time the Royal Navy have made use of these ports, and several battleships have been berthed.

No. 2 Military Port—The deep-water wharf South, viewed from the heavy crane berth.

H.M.S. *Malaya* was fitted out with new guns, necessitating a lift of 90 tons by the giant floating crane at No. 1 Port. The complete facilities of the ports were made available to deal with particularly urgent shipments of cased motor transport at a time when civilian ports were too congested to accept the traffic.

The rate of handling and assembling the vehicles for onward despatch to the U.S. Forces on the Continent constituted a world record. In addition, U.S. personnel have been disembarked at these ports.

It was from No. 1 Port that Mr. Winston Churchill commenced his voyage on the *Queen Mary* to attend one of his historical conferences with the President of the U.S.A., and their Majesties The King and Queen sailed from the Military Port in Loch Ryan to visit Northern Ireland.

Apart from the great value which these ports have served, and the great part which they can play in clearing up the aftermath of military operations and the rehabilitation of Allied troops, the building of them proved to be of the greatest value in connection with the raising and training of the large force of port construction and repair, port operating and inland water transport troops, which was required for operations overseas.

During the construction and operation all classes of work, including difficult under-water work, was experienced. Without such opportunities for training this very large and specialised force it is doubtful whether the very successful work performed by the Port Royal Engineer units in clearing and repairing damaged ports overseas could have been carried out. Certain parts of the force were also employed in connection with the building of the Mulberry Harbour.

Scapa Flow Causeway*

Closing of Eastern Entrances to Fleet Anchorage Area

Two Papers dealing with the closing of the Eastern entrances to Scapa Flow, a natural harbour formed by the mainland of Orkney and a number of adjacent islands, were read before the Maritime and Waterways Engineering Division of the Institution of Civil Engineers on 28th March, 1946. The step was taken by the Admiralty as a means of protection for the anchorage which had proved of great service to the British Naval Fleet during the 1914-18 and the 1939-45 wars.

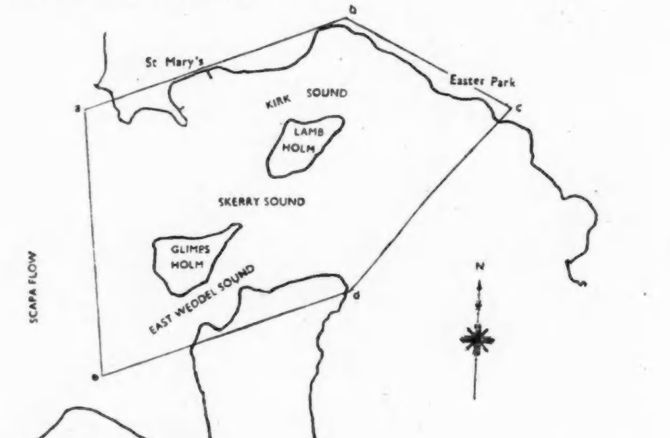


Fig. 1.—Areas comprised in the Models.

The Eastern entrances (Fig. 1) comprise four tidal channels lying between the mainland of Orkney, two small uninhabited islands, Lamb Holm and Glimps Holm, Burray Island, and the large island of South Ronaldshay. They are designated Kirk Sound, Skerry Sound, East Weddel Sound and Water Sound, respectively. These channels had previously been partially obstructed by means of sunken block-ships. The new scheme provided for embankments with their crests above high water level. The shortest of the embankments (that across East Weddel Sound) is about 1,400-ft. in length, whilst the longest (across Skerry Sound) is about 2,100-ft. long. The maximum height from the sea-bed to high water over the sites is approximately 55-ft.; the highest range of tide is about 12-ft. and the maximum current velocity before the start of the work in the neighbourhood of 12 knots.

At the outset, it was decided to carry out a complete model test before determining the methods to be adopted in building the causeways. This investigation was entrusted to Professor A. H. Gibson, of Manchester University. The experiments were carried out by Dr. Jack Allen, and are described in the first Paper. Two models were made with a horizontal scale of 1 : 1,250 and a vertical scale of 1 : 160. Corresponding with this vertical scale, a velocity scale of $1 : \sqrt{160}$ or 1 : 12.6 was assumed, so that 1 knot was represented by 1.60 inch per second.

The questions to be considered were:

(a) the most favourable sites for the causeways;
(b) the current-velocities likely to be encountered as the work progressed. The maximum current so determined was 13 knots.
(c) the size and weight of the material to be used on the construction of the causeways and
(d) the horizontal distance through which blocks of a given size would travel, if dropped from above the water surface.

Problems (c) and (d) were investigated in an existing flume at the laboratory. One of the more important conclusions reached was that higher velocities are resisted by embankments of

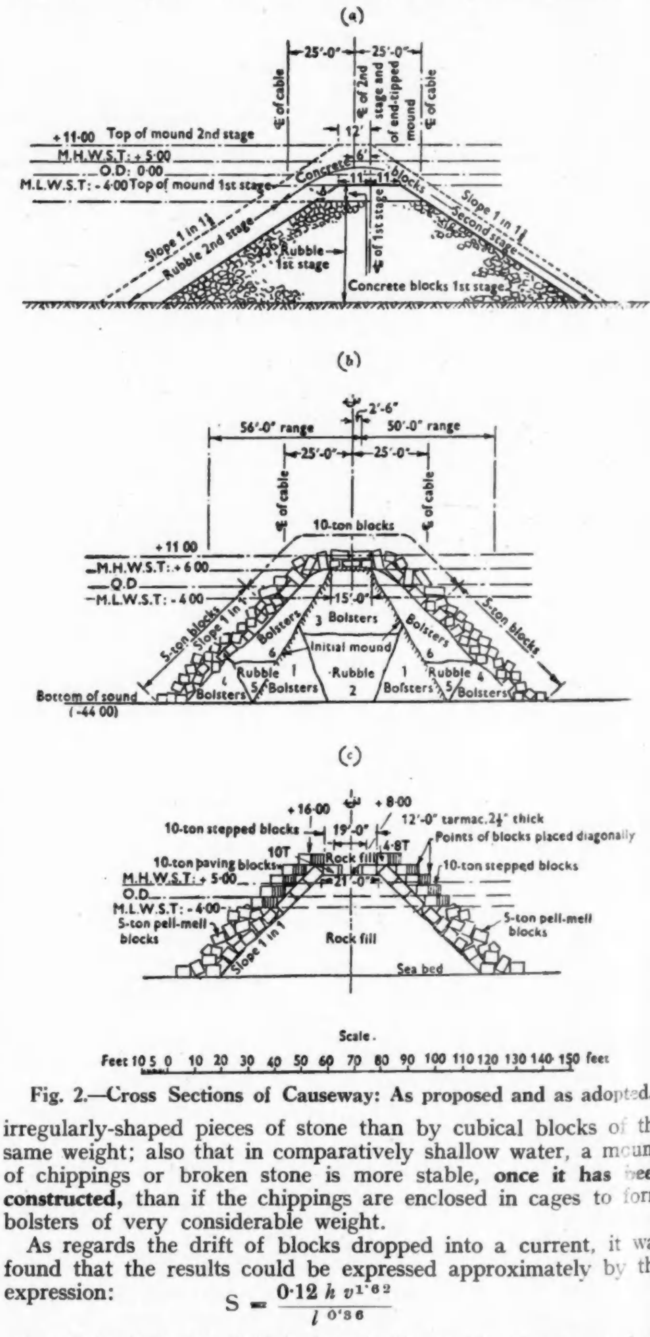


Fig. 2.—Cross Sections of Causeway: As proposed and as adopted.

irregularly-shaped pieces of stone than by cubical blocks of the same weight; also that in comparatively shallow water, a mound of chippings or broken stone is more stable, **once it has been constructed,** than if the chippings are enclosed in cages to form bolsters of very considerable weight.

As regards the drift of blocks dropped into a current, it was found that the results could be expressed approximately by the expression:

$$S = \frac{0{\cdot}12\, h\, v^{1{\cdot}62}}{l^{\,0{\cdot}86}}$$

where S indicates the drift in feet; h, the depth of water, in feet;

***"Laboratory Experiments in connection with Causeways closing the Eastern Entrances to Scapa Flow," by Jack Allen, D.Sc., M.I.C.E.**
"Causeways closing the Eastern Entrances to Scapa Flow," by James Abercrombie Seath, B.Sc., M.I.C.E.
The present article is a substantially condensed summary of these two Papers and is published by permission of the Institution of Civil Engineers.

Scapa Flow Causeway—continued

l, the length of the side of the cube, in feet; and v, the stream velocity in knots. The effect of dropping the cubes from a height diminished rapidly as the water-depth increased.

The design of the causeway is described in the second paper. The diagrams, Fig. 2, show three cross-sections. The first (a) is that originally proposed in 1940 for the placing of fill in the deep portions by cableways and the building of spurs from all shores by end tipping to a point at 6-ft. below low water. The slopes of the embankments were to be $1\frac{1}{2}$ to 1. Only the top and one side of the structure were to be clothed with concrete blocks. The embankment in the first stage would have been 22-ft. wide at low-water level and the completed causeway was to have a top width of 12-ft. at + 11.00 O.D.

Labour and material difficulties rendered a more economical section essential and it was decided to adopt the " bolster " as a method of placing rock fill.

The idea of the " bolster " arose from the contractors' experience of similar requirements at Kut in Iraq, where bags of sand of about 1 cubic metre were placed and held together by coir rope, and it was thought that in the currents to be encountered only very large stone, which it would be impossible to obtain readily, or concrete blocks would remain in place. The conception of employing wire mesh to enclose a load of 5 tons of smaller stones, which would spread out and grip the bottom and other bolsters, was developed from experiments at Deptford. Eventually, a loose-knit fabric of 5-in. mesh woven in 7-gauge wire was produced and manufactured for use. Three-inch mesh with 9-gauge wire was adopted in later stages.

With some experience of bolster placing a new cross-section (b) in Fig. 2 was substituted and the causeways built to this design, except that the embankment was heightened, narrowed and provided with a roadway at 10-ft. about H.W.O.S.T. (+ 15.00 O.D.) as in (c) Fig. 2.

In the process of construction, a layer of 10-ton blocks was first laid close together all over the rock-fill slopes from low water upwards, with the lower blocks resting on the 5-ton blocks, and on top of this flat course, blocks were laid with bases level, or as nearly as possible, and set diagonally. There are five rows, each of which steps back from the one below and the level of the clothing is carried up to + 16.00 O.D. This forms an excellent wave protection and the rock-fill, so far as can be contrived, is shut off from sea erosion. Prudent provision was also made for settlement. A mix of 1 : 2 : 4 was adopted for the blocks.

The main work was carried out by means of cableways, with a maximum load capacity of $10\frac{3}{4}$ tons—four electrically-driven and one steam-driven. To supply electric power, three generating stations were built: one at Lamb Holm with two 325-kilowatt sets, and the other two at Warebanks and South Burray, each with one 260-kilowatt set. There were also employed 24 cranes of from 3 to 10 tons capacity, 58 locomotives, 200 waggons and 19 excavators, together with other plant.

Except in East Weddel Sound, where the whole of the protection is in 5-ton blocks, being less exposed to gales than the others, the protection of the rubble bank consists of 5-ton blocks below low water and 10-ton blocks above.

The total number of protecting blocks was 33,288 of the 5-ton weight and 11,638 of the 10-ton weight, amounting to 160,000 cub. yds. of concrete.

Settlement was fairly severe when the 10-ton blocks and the roadway blocks were being placed and when the cranes, each weighing about 70 tons were in motion, but since then, settlement has been more gradual, and, as could be expected, has been in proportion more or less to the depth of the fill.

The works cost approximately 2 millions and were completed to all intents and purposes in September, 1944, $4\frac{1}{2}$ years after their commencement. The causeways were officially opened by the Rt. Hon. A. V. Alexander, C.H., M.P., on 12th May, 1945.

The scheme was designed by Sir Arthur Whitaker, K.C.B., Civil Engineer-in-Chief of the Admiralty and carried out under the direction of Messrs. H. B. Hurst, C. K. Johnstone-Burt, Dr. Herbert Chatley, and Mr. J. A. Seath, with Messrs. E. K. Adamson and G. G. Nicol as Resident Superintending Civil Engineers.

Book Review

British Standards for Lifting Tackle

B.S. Handbook No. 4 (pp. 355, 12s. 6d.), with an Introduction by Sir William Stanier, F.R.S. General Editor A. L. Haas, I.S.O., M.I.Mech.E. British Standards Institution, 28, Victoria Street, London, S.W.1.

Safety in lifting affects the whole of industry. Every workshop, factory and warehouse; every ship, shipyard, dock and quay; all buildings, power stations and construction projects; have of necessity to handle loads too heavy for manual manipulation. Even the casual passer-by cannot be altogether indifferent to the integrity of appliances which may imperil his safety. During the past two decades, responsible committees of the British Standards Institution have formulated a series of standards for lifting tackle. It is not claimed that, even now, these standards are either exhaustive or complete, but their number and importance justifies the collection and issue in a single volume of those which suspend, lift and lower a load and which are in common use in a large variety of appliances, where failure is liable to result in casualty.

The Handbook is divided into seven sections—fibre, rope, wire rope, terminal attachments for wire rope, chain, terminal attachments for chain, the materials cited in the preceding standards and a final section dealing with the statutory requirements under the Factories Act applicable to the contents of the Handbook. The first five sections contain the technical provisions of 21 published standards shorn of extraneous matter and repetition; the two last sections are supplementary and complementary, but none the less are essential to the purpose of the Handbook which is to make readily accessible all matters relating to such tackle of which purchasers and users should be aware.

The last section sets forth the rules, orders, register and certificates current at the date of publication as legal obligations. So far as is known this is the first time these regulations, which are available in separate official publications, have been brought together as a whole.

In his introduction, Sir William Stanier draws attention to the responsibilities devolving upon the user of lifting tackle as to maintenance and renewal. Assuming original selection to have been correct, subsequent satisfactory service lies wholly with the user to ensure that tackle for a given rated load is never subjected to a greater load. He recommends that one qualified and competent person in each works should be directly responsible to the management for the care, maintenance and renewal of all the lifting tackle employed.

As independent publications, most of the standards included are prefaced by cautionary or informatory forewords which are of equal technical interest to the clauses of the actual specifications themselves; all such matter has been retained in the Handbook and forms a considerable body of information of interest to designers as well as users. In addition, where necessary or desirable. further information is given as editorial notes which it is hoped will add to the reference value of the Handbook. Recommendations as to care and use of fibre rope are included by the courtesy of the Hard Fibre Cordage Federation and the editorial notes on wire ropes are intended to serve a similar purpose. A detailed method of making a five-tuck wire rope splice, based on information supplied by Messrs. British Ropes, Limited, is published for the first time. Standards for both wire rope and chain slings are included.

The numbers of the British Standards included in the Handbook are as follows: Fibre Ropes, B.S. 431, 908, 525. Wire Ropes, B.S. 302, 329, 621. Terminal Attachments for Wire Ropes, B.S. 461, 462, 463, 643, 464, 716, 1290. Chain, B.S. 394, 465, 590. Terminal Attachments for Chain, B.S. 482, 529, 501, 781, 825. Extracts are given from B.S. 15, 18, 24, 84, 729, 762, 858. There are approximately 90 full page Tables and 70 Line Drawings included.

It is only by the use of good lifting tackle and unremitting care that preventable hazards can be eliminated and it is the purpose of the Handbook to provide safe standards with advice as to their use. The compilation of the Handbook has long been needed and it should be of service wherever lifting tackle is employed.

Notes of the Month

Date of New Customs Union.

The common customs tariff of Holland, Belgium and Luxembourg will take effect on January 1st next. The date for the abolition of the customs boundary between these countries is fixed at November 1st, 1947.

Construction of Tyne Tunnel.

The first step in the construction of the Tyne tunnel between Jarrow and Howdon has been taken with the sinking of a test bore on land at Jarrow Ferry. Other bores will be sunk near the Golden Fleece Hotel, Jarrow, and at the ferry landing, and near Church Street, Howdon. Actual construction is not expected to start until next spring.

Danube Craft to be Returned.

It is reported that the United States will shortly return 400 confiscated Danube boats to Yugo-Slavia, Czechoslovakia, Hungary and Rumania. The boats are being returned without reference to the United States proposal for a Danube conference. Hitherto, it has been contended that the authorities could not move the boats from Austria owing to chaotic conditions in the river.

Reconstruction Plans for Port of Glasgow.

Reconstruction of Queen's Dock, Glasgow, to give berthage for 13 ocean ships with full shed, rail and other facilities is under consideration by the Clyde Navigation Trust. The scheme was mentioned in a minute of the joint general purposes, harbour and traffic committees submitted to the Trustees early last month. These joint committees, it was stated, are continuing consideration of the project pending a report by the general manager on its financial and trading aspects.

Belfast Harbour Rates to be Increased.

Belfast Harbour Commissioners have decided to raise the surcharge on rates on goods and vessels from 30 to 45 per cent. The increase, which will have effect from January 1st, is mainly due to the need to make good the arrears of harbour maintenance and other works which had accumulated during the war, and to increases in wages and in the cost of materials. It is hoped that the new surcharge will enable the Board to keep ahead of expenditure in the coming year.

Trade at South Wales Ports.

The Ministry of Transport is to divert more bulk-purchased imports to South Wales to increase employment at the ports. In particular goods for distribution in the Midlands, Wales and West England will be handled, and it is hoped that increasing production in new Welsh factories and goods from the Midlands will also increase the export trade of the ports. It is understood that congestion at London, Liverpool and Southampton, and resulting delays in loading and unloading had an influence on the Ministry's decision.

Thames Barrage Scheme.

In the House of Commons recently, the Minister of Town and Country Planning was asked whether he was aware of the proposals for a Thames barrage to produce a tideless river in the London reaches; and whether, in view of the importance of this project to any plan for the reconstruction of London, he, in consultation with the Ministers of Transport and Health, would cause a public enquiry to be held at which all bodies of opinion might, for the first time, publicly be heard. In a written reply, the Minister said he was aware that a scheme has been put forward by the Thames Barrage Association, but he did not consider that the effect of the project on plans for the reconstruction of London would be such as to warrant at present the exhaustive investigations which would be necessary in view of the many interests affected and the conflicting technical opinions held. The Ministers of Health and Transport concurred with him in the view that a public enquiry cannot be contemplated at the present time.

Rotterdam Timber Traffic.

As a result of recent discussions between the Dutch Commission for Navigation on the Rhine and the American occupation authorities in Germany relating to the transport of timber from the Black Forest to Great Britain, it has been arranged to ship the greater part via Rotterdam. The quantity involved amounts to more than 100,000 tons of sawn wood, destined for the construction of emergency dwellings.

Improvements at the Port of Hull.

Big improvements in dock facilities at Hull are expected as the result of protracted discussions which have been taking place between the London and North Eastern Railway and Hull shipping and commercial interests. Extensive plans have been prepared which should ensure an all-round improvement in amenities, but no detailed disclosure has yet been made of the improvements contemplated. It is understood that approval to the plans has been given by the Hull Shipping Committee.

Irish Lightships to Return to Stations.

The Irish Lights Commissioners have decided to replace the light-vessels which before the war were on their stations around the East and South Coast of Ireland. During the war the lightships were withdrawn because of danger from drifting mines. They have been moored in various anchorages and have been maintained in working order. The South Arklow light-vessel which marks a sandbank off the Wicklow Coast is to be restored immediately. Next will follow the Blackwater and the Barrells, off Wexford. Each will be equipped with submarine fog signals and radio telephone to warn shipping.

Wind Tests for Severn Bridge.

Scientists from the National Physical Laboratory are to carry out a special investigation for the Ministry of Transport into the effect of wind forces on a model of the proposed 3,000-ft. span suspension bridge over the River Severn. The tests will be made in a specially-designed wind tunnel, large enough to house a model 52-ft. long, in which it will be possible to observe the effect of a wind striking the bridge from any quarter. The tunnel, one of the largest in the country, is being built under the direction of the Ministry's engineers. It is hoped to complete it in time for experiments to begin early next year.

Rehabilitation of Penang Harbour.

Details of the progress in rehabilitation at Penang Harbour have been given by the chairman of the Harbour Board, who has reported that progress has been so good that it is now possible to start work on schemes for new development. During the war the depth of water alongside Swettenham Pier had deteriorated from 32-ft. to as little as 18-ft. in some places, but dredging has again increased it to a minimum of 30-ft. An important feature of the port is its godowns, whose total capacity of 178,730 sq. ft. pre-war had been much reduced by bombing. After rebuilding the capacity is now 137,300 sq. ft. This work also involved a great deal of repairs to Swettenham Pier, and the quay wall in front of godown No. 5 was being rebuilt with steel-sheet piling.

Projected Extension at the Port of Sunderland.

Sunderland Town Council are considering the promotion in the present session of Parliament of a Corporation Bill to give powers for the projected extension of the Corporation Quay at an estimated cost of £35,480. The Corporation will seek powers to construct the extension with quay walls, railways, bridges and other works; to increase the rates for vessels and dues on goods, etc., authorised for the Corporation Quay by the Act of 1927, and to apply the new rates to the extended quay to provide for the exercise of running powers over the railways of the River Wear Commission; and to provide cold storage facilities. The Corporation already has powers for the building of a public cold store on a site adjacent to the quay, and has approved plans for proceeding with this scheme.

The Port of Calcutta under War Conditions

Description of an Efficient Emergency Organisation

By J. S. B. GENTRY, C.I.E., O.B.E.

Calcutta as a Military Base

IN every theatre of war from 1939-1945 it was a fundamental pre-requisite to the success of Allied arms that there should be available one or more base ports of considerable capacity and of high operating efficiency. For example, the B.E.F. in 1939-1940 was supplied mainly through Le Havre, Cherbourg, Brest and Nantes, while the Western Desert Forces in the Middle East, 1940-43, were maintained through Suez, Port Said and Alexandria. To fulfil the same function for the operations in Burma, supplies to China and potential activities against enemy-occupied Malaya, Calcutta, on account of its size and geographical position, was the obvious if not the only port that could provide the necessary facilities for the reception and despatch of war material and equipment of all descriptions. The smaller ports in the Bay of Bengal, viz., Vizagapatam, Madras and Trincomalee, were also employed for military traffic and served as useful additions to Calcutta, while Bombay was utilised almost solely for trooping, it being impracticable to transport large quantities of war stores across India to the forward areas.

It should be stated in any account of the part played by Calcutta during the 1939-45 war that, in the early years, i.e., until the entry of Japan, considerable port equipment such as tugs, lighters, cargo handling gear and mooring material was transferred from Calcutta to other war areas which were at that time more actively engaged, notably the Middle East. The effect of this transfer of equipment was to accentuate port working problems when the war came nearer to Calcutta, and that port was at short notice called upon to work to capacity and the borrowed material could not be returned because it was fully employed elsewhere. In addition to the transfer of equipment, large numbers of technical staff normally employed in the port, such as pilots, traffic officers, stevedores and supervisors, were also released for service with the Forces and other organisations, and their absence from Calcutta at the vital period was a serious impediment.

The sudden and heavy increase in import traffic directed to Calcutta which, besides British and American military stores, included large tonnages of essential civilian supplies, such as wheat and salt, was a great strain on the port, especially as regards heavy and awkward cargoes requiring specialised handling and clearing arrangements. This influx commenced in mid 1943 and, well as the permanent civil staffs, assisted by military and naval organisations worked, temporary congestion was inevitable.

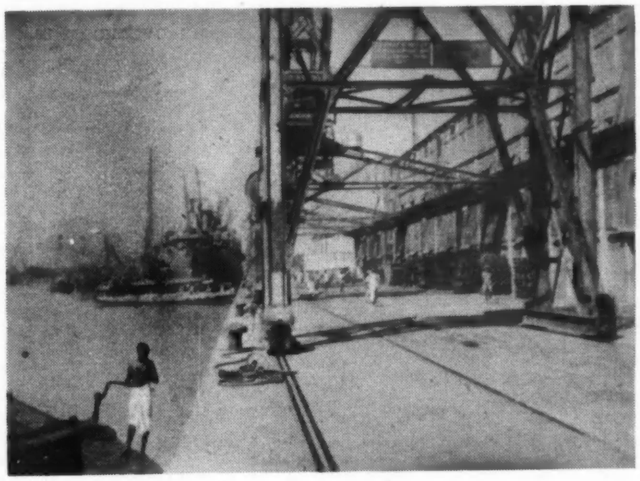
Regional Port Directorate

The excess importations remaining in the dock area were cleared quite quickly, but it became apparent that if the port was to handle the increased tonnages required over a sustained period and ship turn round was to be expedited, a central co-ordinating authority super-imposed upon all existing authorities, both civilian and Service, British and American, was desirable. The Government of India therefore decided to set up a Regional Port Directorate for Calcutta under the control of its Member for War Transport (Sir Edward Benthall) and also a Director of Railways, who would be responsible to Government for the co-ordination and control of all port operating and railway working respectively in the Calcutta area. Mr. F. A. Pope (now Vice-President of the London, Midland & Scottish Railway) was appointed Port Director, with two deputies, one British and the other American. Sir Robert Marriott, of the East India Railway, was appointed Director General of Railways. The two Directorates commenced to function in April, 1944, and worked very closely with one another in all matters throughout their existence, i.e., until the end of 1945. When Mr. Pope returned to the United Kingdom in January, 1945, he was succeeded in March of that year by Sir Godfrey Rhodes.

An examination of port working conditions and facilities indicated that after some re-organisation of methods, the provision of a comparatively small amount of additional equipment, principally tugs, lighters and mobile cranes, and improvement in ship's advices and down river communications, the Port of Calcutta would be able to handle a tonnage of 600,000 tons d.w. per month, excluding coal and bulk oil. It was understood at that time that this figure would meet anticipated requirements. It was, in fact, substantially exceeded.

Transit Areas Established

Now although it was estimated that the port could physically handle across the quays the tonnage stated, it was simultaneously realised that without some drastic alterations in the clearing arrangements, particularly in respect of cargoes such as barge



King George Dock, Calcutta.

parts, cased vehicles, heavy steel work and similarly awkward goods, congestion would recur, capacity would be reduced and ship's turn round retarded. Two measures were therefore introduced, with the assistance of G.H.G. India and the Calcutta Port Commissioners, which were designed to obviate these probabilities.

1. Arrangements were made for the Port Directorate to receive as full details as possible of importing ships' cargoes and their arrival dates as far in advance as practicable. On receipt of this information, disposal instructions were obtained from all consignees so that on the arrival of a ship there was no delay, on this account, in despatching the cargoes away from the dock area. The availability of this information was of inestimable value to the Port Berthing Committee, which met several times weekly and were thus able to direct ships to the most suitable berths.
2. Two intermediate transit areas, one for handable and the other for non-handable cargo, were established, to which consignments not readily deliverable to final destination could be directed in order to keep the dock quays and sheds clear. These areas were adjacent to the docks and were road and rail served. The one allocated for non-handable cargo had a capacity of 20,000 tons and the other consisted of covered accommodation with a capacity of approximately 10,000 tons.

Port of Calcutta under War Conditions—continued

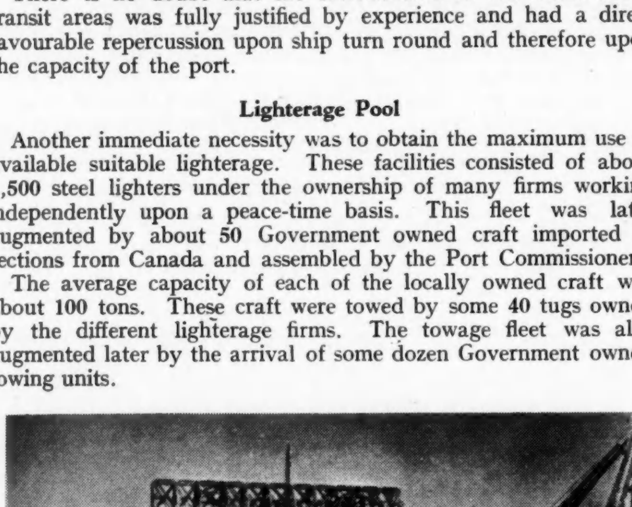
Of the total importations it was necessary to remove only a small proportion to these transit areas and, although it was fully appreciated that double handling was involved in the process, the alternative of congestion at the ship discharging berths was naturally unacceptable. In any event, a large number of items directed to this temporary accommodation comprised cargo such as barge parts for assembly and use in the port, cased vehicles for assembly at adjacent depots, or other awkward cargo for eventual re-export from Calcutta.

There is no doubt that the introduction of the intermediate transit areas was fully justified by experience and had a direct favourable repercussion upon ship turn round and therefore upon the capacity of the port.

Lighterage Pool

Another immediate necessity was to obtain the maximum use of available suitable lighterage. These facilities consisted of about 1,500 steel lighters under the ownership of many firms working independently upon a peace-time basis. This fleet was later augmented by about 50 Government owned craft imported in sections from Canada and assembled by the Port Commissioners.

The average capacity of each of the locally owned craft was about 100 tons. These craft were towed by some 40 tugs owned by the different lighterage firms. The towage fleet was also augmented later by the arrival of some dozen Government owned towing units.



New Heavy Lift Yard, King George Dock.

Prior to the introduction of the Port Directorate, it had been decided to form a Lighterage Pool and early steps had been taken in this direction, the Government giving the Chairman of the Port Commissioners the requisite powers. These powers were transferred to the Port Director upon his arrival and the detailed work of organising the Pool on a satisfactory basis, both from the practical and financial points of view, was carried out. On the practical side, all demands for tugs and lighters had to be made to the Port Directorate, who decided allocations and priorities. Lengthy negotiations took place with the lighterage interests respecting financial arrangements, and eventually a schedule of rates was issued by the Port Director. A Management Committee, on which the lighterage firms were represented, was set up to deal with the many administrative matters which arose.

The operations of the Lighterage Pool were improved by the arrival of eight army N.C.O.'s, who were experienced London lightermen and whose despatch to Calcutta was requested by the Directorate. These men came from the Middle East and were distributed over the whole of the port area, with instructions to facilitate the movement of all Pool tugs and lighters. One of them was placed in charge of the Tug Control Office. Their contribution to the port war effort was most praiseworthy.

The Daily Port Meeting

Before the arrival of the Port Director in Calcutta, a working meeting was held about three times a week under the chairmanship of the Dock Superintendent, Port Commissioners. This meeting dealt mainly with clearance problems and was attended by Army Movements, Ministry of War Transport, War Shipping Administration (U.S.) and others at infrequent intervals. Although no current statistics were available, nor was ship berthing or working examined in any detail, the meeting was a useful one and formed a good basis for its successor, the Daily Port Meeting. This meeting was introduced early in June, 1944, under the chairmanship of the Deputy Port Director, and was held daily. The representation at the meeting was extended and full statistics of the previous day's ship working were provided by the Ministry of War Transport and were made available in statement form. In addition the current railway, lighterage, motor transport position and other relevant information was available at the meeting.

A representative Berthing Committee, which met twice or thrice weekly, was also introduced. This Committee had before it detailed plans of all ships expected to discharge in Calcutta in the next six days or so. Consideration of these plans by the interests concerned enabled the best arrangements for berthing and clearance to be made. It should be mentioned in this connection that a considerable volume of detailed work was involved in the preparation of the berthing plans, which contained comprehensive information concerning the ship, viz., length, draft, derrick capacity, deck cargo, as well as the weights of heavy packages requiring shore or floating equipment and disposal arrangements for the whole of the cargo carried. These plans were produced by the Directorate Staff, invariably against time, so that the Berthing Committee would be provided with the fullest information and therefore be in a position to make the most suitable berth allocation.

Traffic Re-organisation

The four measures described above, i.e., Ships Advices, Intermediate Transit Areas, Lighterage Pool and Daily Working and Berthing Committees, formed the basis upon which co-ordination and control of the daily port working was maintained. Each of them was complimentary to the other and the breakdown of any one would probably have had serious results. There were, however, a number of other matters directly or indirectly concerned with port operations which required attention and these were duly taken in hand. A brief outline of these matters and the action taken follows.

> The Port Commissioners had released a number of their outdoor traffic staff to the Services and it was clear that many of the remaining shed staff were not taking sufficient responsibility for the turn round of a ship. In conjunction with the Chairman, Port Commissioners and his Senior Traffic Officers, a detailed investigation was made of the working of the Traffic Department. This department was re-organised and given additional responsibilities, including that of being primarily concerned with ship turn round. Special increments in pay were granted, a comprehensive system of telephones introduced and office improvements effected. The subsequent satisfactory improvement achieved, justified the measures taken and was a tribute to the untiring energy and zeal of the Docks Manager.

The necessity for making the fullest possible use of civilian resources in operating the port was appreciated, but the staffs of the many interests working in the port were so depleted that it was apparent that the available supervision on ship and shore would not be sufficient to obtain maximum efficiency. Representations were made to obtain the release of officers formerly employed in the port, but only one or two could be spared from the Services. The only other source from which assistance might be obtained was the army, i.e., from Transportation Units.

It is relevant at this point to make reference to port conditions in the six months prior to the setting up of the Directorate, because, up to that time, a rather thin but enthusiastic Army Movements' Organisation, plus a few Transportation personnel, were the only additional aids to the depleted civil staffs that were available to supervise the handling of increasing military traffic that was of a much more difficult character than that to which the port was

Port of Calcutta under War Conditions—continued

accustomed in peace time. The Army Movements' staff had its own particular duties to perform, so that the Transportation personnel, consisting of H.Q. No. 6 Docks Group and one (No. 1016) British Dock Operating Coy., R.E., was all there was to augment the civilian staff. In point of fact, No. 1016 British Dock Operating Coy. did not arrive until January, 1944.

In October, 1943, it was agreed by local army and civilian authorities that good use could be made of untrained category B.O.R.'s for supervising the labour in the docks. This suggestion was acted upon and No. 1 Port Supervising Coy. was formed, given a short course of training, and employed on the docks by the beginning of 1944. After the arrival of the Port Directorate, two additional similar Companies were formed and introduced.

The air raid on December 5th, 1943, resulted in practically all civilian labour disappearing. Army labour (Pioneers and Transportation troops that happened to be in the district) were brought in, in the endeavour to keep things going. The organisation of this labour was undertaken by H.Q. No. 6 Docks Group, acting under the direction of the Port Commissioners. The number of troops employed in the docks in December, 1943, rose on occasion to over 3,000, and men from the Garrison Battalion were employed until the middle of January. Thereafter, civil labour gradually returned to work and finally only real Transportation troops and Pioneers were employed, and these were confined to sea transport berths.

No. 1016 Dock Operating Coy. contained a number of British stevedores with considerable pre-war experience. They were used to good advantage. In addition, a Stevedore Warrant Officer was employed full time in watching the complete discharge of selected ships. He made daily reports of a constructive character and these were summarised into a complete report on each ship. Ships were chosen in consultation with the Ministry of War Transport, and copies of the final report were sent to Agents, Port Commissioners, and later to the Port Directorate.

The above-mentioned scheme was extended on the arrival of the Port Directorate. A number of suitable military officers and B.O.R.'s were appointed Zone Inspectors and Assistant Zone Inspectors, and allocated to different areas in the port. They were not given executive powers, but their function was to discover what was wrong, assist in putting it right, and generally to keep in touch with the working of the ships, lighters, cranes, transit sheds and clearance facilities. The Zone Inspectors worked under the control of the Port Directorate, through H.Q. No. 6 Docks Group, to whom they were immediately responsible. Every Zone Inspector carried a document signed by the Port Director, which was his authority to act.

Although the Lighterage Pool was rapidly increasing in efficiency, it was apparent that insufficient use was being made of lighters to expedite ship discharge. A Port Director's order on the subject was issued, directing that the maximum use of craft, when available, was to be made for this purpose. The order also gave directions as to whose responsibility it was to order the craft and as to who would bear the cost.

A detailed survey was made of the cargo handling gear available in the port and assistance was given to stevedoring firms and others to obtain new or additional gear either by release of materials for its manufacture or ordering it from elsewhere. A large quantity of mechanical equipment, such as mobile cranes, tractors and fork lift trucks, was ordered.

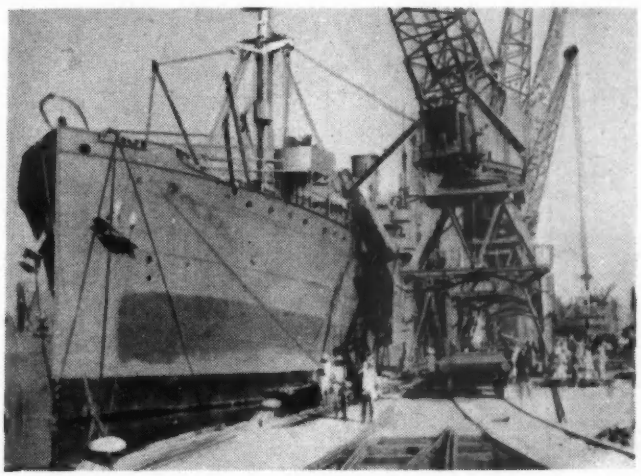
The requirements of the port in the matter of harbour craft of all types, especially tugs for the Lighterage Pool, were co-ordinated and a demand placed on Government.

In addition to the major works they were constructing (referred to below), the Port Commissioners re-surfaced a number of transit sheds and quays and effected improvements to railway lay-out at the same time.

The arrangements for the supply of fresh water to shipping were inadequate. In agreement with the Principal Sea Transport Officer, all water boats used for supplying fresh water to shipping were pooled under the immediate control of the Divisional Sea Transport Officer. An additional self-propelled water boat was ordered from the Government, while one or two dumb barges were equipped with tanks and used in the Pool. It should be mentioned that the supply of fresh water to shipping, even after the marked improvement brought about by the formation of the Water Boat Pool, was always a problem, and delays to ships on this account were not infrequent up to the end of the Directorate's existence. The Divisional Sea Transport Officer's staff are to be commended for their share in the improvement that was effected.

Down river communications were considerably improved by the installation of direct telephone lines to Budge Budge and Hooghly Point, while direct short wave telegraphy was inaugurated between Deputy Port Officer (Pilotage) at Marine House and the Pilot Brig at Sandheads in August, 1945.

A special investigation into the working of military traffic loaded into Sea Transport vessels was undertaken by the Directorate, who had on its staff officers who had acquired specialised experience in this type of work in other theatres of war. A comprehensive report covering all the different factors, from the calling in of the traffic from depot to the loading operations on the ships, was prepared. Most of the proposals in this report were adopted and an officer of the Directorate was allocated full time to assist Army Movements and the Sea Transport Service. The turn round of these ships was accelerated as a result of the action taken.



New Deep Water Berth, Kidderpore Dock.

Pilotage Problem

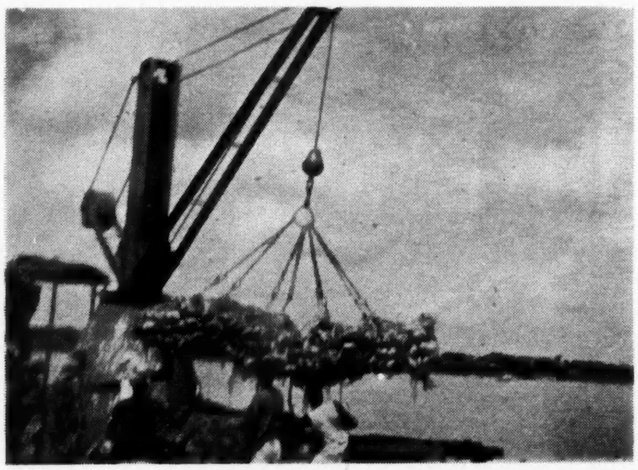
A major problem arose during the first few months of 1945, when the increased numbers of ships using the Port of Calcutta confirmed earlier anticipations that the capacity of the port was governed by the number of river pilots and assistant harbour masters available to conduct ships up and down the River Hooghly and to and from their working berths. Several pilots had been released for service duties elsewhere in the earlier days of the war and could not be returned to the Bengal Pilot Service immediately. The situation was eased by the loan of pilots with experience of other ports, but these officers could only undertake comparatively simple jobs. The River Hooghly has many vagaries and it is a fact that only after many years of training can a pilot be considered qualified to conduct the largest vessels up and down the river. The Bengal Pilot Service, as well as the Port Commissioners Harbour Master's staff, worked wonderfully well under onerous conditions and are entitled to much credit for the results achieved.

Jute Cargoes.

In addition to the heavy volume of import and export traffic handled across the quays, a large tonnage of cargo was carried by river flats. An average of 8,000 bales of raw jute which arrived from up-country in these craft was discharged daily and practically all of it was received into Pool lighters, which automatically reduced the availability of those craft for ship work. It was

Port of Calcutta under War Conditions—continued

extremely important, however, to discharge river flats quickly, because jute was a war material in urgent demand and, moreover, the flats returned up-country loaded with military stores for the forward areas or for on-carriage by air or road to China. Operations connected with the discharge and turn round of river flats were frequently adversely affected by conditions in the river; due to low water levels at different points, flats accumulated and arrived in bunches instead of in the even flow that would have been desirable. To effect a saving in the use of lighters for these operations, efforts were made to have the flats loaded with jute up river for the minimum number of destinations in Calcutta, so that on arrival in the port they could discharge direct alongside the mill or press. When loading military stores outwards, the flats invariably berthed alongside special pontoons or quays provided for the purpose. It is appropriate to mention in connection with the traffic in river flats and jute, that about **50** per cent. of the available lighterage fleet was always engaged in carrying jute or jute products either during the discharge of flats or the conveyance of raw and manufactured jute from the mills to export vessels. So large and important was this traffic that the early step was taken of inaugurating a Joint Jute/Lighterage Committee. This was held weekly at the Bengal Chamber of Commerce, under the



Landing Jute from Lighter.

chairmanship of the Directorate, and was attended by the several Jute Trade Associations, Shipping Agents and Army Movements. Current working conditions were thus kept under constant review and many problems were solved or avoided by this means. As port working became more efficient, it was later found possible to reduce these meetings to once a fortnight.

As has been mentioned earlier in this account, the port was called upon to handle a heavy tonnage of important commodities in addition to general imports and exports of war material. Some of these commodities were essential to the well-being of the population, e.g., salt and wheat. Special attention had to be given by the Directorate to the discharge of salt, which is subject to Customs Duty and in April, **1944**, was particularly slow, operations being impeded by trade practices of many years' standing, arguments between the many interests involved, and graft. A great deal of time was spent in investigating and re-organising the procedure for handling this commodity and, as a result, the daily average discharge per ship rose from **710** to **1,500** tons d.w. per day.

Bulk wheat was imported in large quantities and the discharge was similarly improved, the rate rising from about **700** tons to **2,000** tons d.w. per ship per day on average. It may be of interest to record the method adopted, which was almost entirely by hand. Sacks were filled by hand in the ships' holds, sown up, landed by crane or derrick, and cleared mainly by road conveyance. Several examples of good work were recorded, viz., when over **4,000** tons d.w. were discharged from a ship in a day of approximately **19** working hours.

Some reference to labour conditions and arrangements must be made in this account, although it was surprising that apart from the defection caused by the December, **1943**, air raid mentioned earlier and the temporary delaying effect occasioned by air raid warnings, the port was remarkably free throughout the vital war period from anything approaching serious labour difficulty. It must be said at once that the stevedores and the stevedoring firms are to be commended on the satisfactory results produced. Once they realised the increased pace that was required and the necessary enthusiasm had been infused, the daily output and aggregate tonnages handled mounted rapidly, as is indicated in the statistics given below. The shore labour organisation operated by Messrs. Bird & Co. and the Port Commissioners worked equally well, having regard to the fact that the coolie labourer employed on the quays and in the sheds and local depots was, as would be expected, of marked inferior quality compared with the ship men.

Bonus schemes for labour, both ship and shore, were introduced as incentives; hours of work on the ships, shore and in depots were adjusted and co-ordinated: while regular monthly meetings were held, at which were represented all stevedoring firms, the shore labour contractors, the Port Commissioners and the Ministry of War Transport.

Speedy Turn-Round

The speediest turn-round of ships was the Directorate's primary objective. This, of course, involved and was inseparable from a number of other contributing agencies, to which reference has already been made, e.g., the efficient use of lighters, rapid clearance of quays and transit sheds and adequate supply and use of all types of cranes and other equipment. The actual work on the ships themselves (once they were berthed to the best advantage), however, was the beginning of the operation and immediate attention was therefore concentrated on this phase. All shipping agents, stevedoring firms and shore labour contractors in Calcutta were contacted at meetings and in the daily course of business. Indifferent work and delays were taken up by correspondence, telephone and by personal interview. After a few months this procedure was intensified by special meetings with all concerned on technical questions and by rapid follow up of reports from the Zone Inspectors and of unsatisfactory situations revealed by the daily working statistics. On many occasions the Port Director discussed and explained requirements to the heads of shipping firms.

The results of these activities were satisfactory. The rate of ship discharge and loading improved **25** per cent. and increased month by month, until an average rate of over **1,300** tons d.w. of general cargo per ship per day was achieved in March, **1945**. This enabled the port to deal rapidly and efficiently with an important increase in aggregate tonnage of all types of cargo which, excluding bulk oils, rose to nearly **800,000** tons d.w. per month compared with **500,000** tons d.w. in the month of June, **1944**.

The following tables give a comparison of the average rates of discharge and loading per ship per day (in tons dead weight) over the six months ended June, **1945**, compared with the month of June, **1944**.

Rates of Discharge.	**1944**			**1945**			
	June	**Jan.**	**Feb.**	**March**	**April**	**May**	**June**
Ocean General ...	590	861	1,035	1,150	1,077	904	774
Salt	710	1,547	1,748	1,525	1,396	1,472	1,033
Grain (bulk)	—	—	—	—	—	1,764	—
Bitumen and Cement ...	580	1,500	1,693	1,696	1,481	1,576	1,120
U.S.A. Transports ...	1,160	1,470	1,516	1,418	1,595	[illegible]	1,421
Aggregate (Ocean) ...	730	1,136	1,216	1,323	1,248	1,117	870
Coastal	420	1,039	1,057	1,288	1,456	784	942
Rates of Loading.							
Ocean General—Docks ...	710	831	1,169	1,032	1,167	1,070	957
Ocean General—Buoys ...	520	705	953	747	742	[illegible]	421
Aggregate Ocean ...	660	773	1,110	989	1,052	[illegible]	809
Hired Transports ...	590	446	618	654	580	[illegible]	572
Coastal	590	770	891	797	695	583	751
Coal	1,190	797	1,268	1,375	1,370	1,374	1,340

Immediately it became apparent that Calcutta Port was likely to be called upon to deal with increased tonnages, the Port Commissioners embarked upon an extensive programme of new works.

Port of Calcutta under War Conditions—continued

This was in **1943**, and, by the time the Port Directorate was set up in April, **1944**, the construction programme was in full swing. It included:—

- Five new deep water ship working berths,
- One ship laying-up berth,
- Two flat loading berths,
- One heavy lift yard,
- Two personnel embarkation jetties, and
- A new first-class diversion road, **4,000**-ft. in length.

All these valuable facilities were completed in time to prove of the utmost assistance to the build-up of the war potential and subsequence maintenance of the Forces in Burma, China and elsewhere.

The planning and construction work was undertaken by the Engineering Department of the Port Commissioners with remarkable vision and at a most extraordinary rapid pace. The Allied High Command should indeed be grateful for this vital contribution to final success.

The traffic arriving for account of the American Army, including supplies to China, comprised an average of about **200,000** tons d.w. per month, or approximately one-quarter of the total tonnage passing in or out of the port across the quays. With the exception of a few consignments, the whole of this cargo was carried in U.S. Army Transports and was discharged in the modern King George Dock. There were five ship berths in this dock and they were, for the greater part of the period under review, all allocated to and operated by the American Army Transportation Corps, who were responsible for all ship and shore operations, with the exception of railway working and crane driving. Civilian stevedores were employed in the ships, but all the supervision was American. The average rate of ship discharge maintained by the U.S. Army was **1,400** tons d.w. per ship per day, and it is noteworthy that in all theatres of war in which the American Army were operating their port working figures for Calcutta were always at the head of the weekly statistics issued.

Experience in Port Administration

Looking back over a year ago at the interesting, absorbing and instructive period covered by the active operations of the Calcutta Regional Port Directorate, it is not easy to arrange in order of importance the value of the experience in port administration and operating that was undoubtedly gained. The feature which does linger in the mind is the very whole-hearted enthusiasm and spirit of co-operation and determination to solve problems and produce results that was disseminated by everyone directly concerned in the many phases of the work from the Chairman of the Port Commissioners, Sir Thomas Elderton, to the rank and file engaged on the dock quays. The primary lesson is, therefore, that no matter how high the quality of the physical characteristics of the ship berths, the adequacy of the cargo handling equipment, the capability of the stevedores, shore labour and its supervisors, the availability of lighters and so on, maximum efficiency can only be obtained and sustained if there is real interest and enthusiasm among all concerned in the task in hand. This necessity is, of course, involved in all operations of a complex nature, but it is particularly applicable to the operating of a large port under war emergency conditions.

The experience in Calcutta again confirmed the paramount necessity to keep the dock transit areas, i.e., quays, sheds and yards clear of cargo if capacity working is to be achieved. This calls, in the first place, for adequate information in advance of ships' cargoes and full disposal instructions for them, together with reasonably accurate ship arrival dates—not always practicable in war on security grounds alone. If satisfactory disposal instructions are not available in good time, the finest railway, road or other clearance facilities are practically useless. The Port Director in Calcutta had powers to order the removal of any goods in any ownership when no disposal orders had been received, but these powers were only used in one or two instances.

In war, as in peace, full but intelligent use must be made of lighters to expedite ship turn round. This, of course, involves double handling of cargo when the craft have to be discharged subsequently and their contents delivered by rail or road or, in the case of exports, when the cargo arrives in the port by those means; but the ship is the main consideration, especially under emergency conditions, and the method is fully justified by reduced berth occupation. The best use of the lighters themselves is usually obtained by pooling, as has been described.

A marked feature of the traffic in war material passing through a port is the high proportion of awkward or heavy packages beyond the capacity of the normal shore cranes and sometimes of the ship's purchase. Such items as tanks, cased vehicles, cased gliders and aeroplanes, barge parts, tugs, locomotives and steel work arrive in considerable volume and unless special arrangements are made in advance to deal with them the general flow of the work will be retarded. In Calcutta, the Port Commissioners realised this early in the campaign and foresaw that traffic of this type would increase. To meet it, they constructed heavy lift yards equipped with cranes of ten, fifteen and twenty-five ton capacity. These facilities proved valuable additions to similar smaller ones, which already existed. The packages were discharged overside into craft by ship's derrick or floating crane, the lighters being released at the heavy lift yards, which were all road and rail served.

Under war conditions it is clearly necessary for there to be a central co-ordinating and controlling authority for all operations that take place in a large base port. The powers conferred on this authority must be as wide as possible and involve the minimum reference to Government or G.H.Q., as the case may be. The different interests responsible for port operations, e.g., shipping agents, stevedores, shore labour organisations, lightermen, may be efficient, but so many unexpected factors arise—both external and internal—that repercuss on the work that guidance, direction or decision from a central body that see the whole picture is indispensable if maximum benefit is to be obtained.

A subsidiary lesson of this is the desirability of having one authority, answerable to the central one, who should be responsible for ship turn round. Where a permanent dock authority exists, they should assume these duties. If this principle is not set up and maintained, mutual accusations by the different contributing interests will result and the work will suffer.

This account would not be complete without a specific reference to the ready co-operation and assistance given by Government and G.H.Q. India whenever required and by all local organisations, Service and Civilian, as well as the Directorate of Railways, Calcutta.

A Sounding Survey of the River Orwell

The Hydrographic Department of Marine Instruments, Ltd., has recently completed a sounding survey of the River Orwell for the Ipswich Dock Commission. This is the first to be made since 1932-33. Soundings have been taken from the Ipswich Lock gates down to the Commission's boundary with the Harwich Harbour Conservancy Board at Shotley Spit. An area off Landguard Point has also been surveyed for the Harwich Harbour Conservancy Board.

In surveying the Orwell, fixed marks were first set out at intervals along each bank so that transits could be run across the river at right angles to the navigable channel. These marks were measured out from Ordnance Survey points. Transits from the lock gates to the sewer outfall off Wherstead were spaced at **100**-ft. intervals except off the shipping berths at Cliff Quay where they were made every **50**-ft. From Wherstead to Shotley Spit major transits were spaced at **500**-ft. intervals with two minor transits between each major. On the major transits soundings were taken as close to each bank as the state of the tide permitted, whilst the minors only covered the channel. As at low water the Orwell dries out almost to the channel, soundings were only taken in the period from **3** hours before to **3** hours after high water.

During the survey a total of over one million soundings were taken in six weeks, of which **80,000** were plotted on specially prepared charts to scales of **6** and **25**-in. to one mile.

Research of Tidal Rivers in the Netherlands*

A Successful Combination of Theory and Practice

By DR. J. VAN VEEN
Chief of the Tidal Research Department of the Rijkswaterstaat, Holland.

(Continued from page 171)

Self-Recording Gauges.

There are 74 recording gauges along the Dutch coast, many of which have worked without interruption for decades. Owing to this, the vertical tide along and inside the coast is known thoroughly, but out in the open sea little or nothing is known. In order to learn more about the tides further from shore, the tide-meter shown in Fig 6 is used. It is based on the manometer principle, and records the vertical tide during a 16 days period. The greatest depths where it can be used is about 15 metres at high water. They are placed, therefore, on the sand banks in the North Sea.

Fig. 6.—Registering Tide Meter for Open Sea.

It is the velocity of propagation of the tidal wave along the coast which determines the inclination of the river to flow out towards the left or towards the right. As along the Netherlands coasts, the propagation takes place from the Straits of Dover northward, the river mouths of these coasts tend to flow out in a south-western direction. If the said velocity of propagation is small, as is the case in the shallow waters which prevail along the Dutch coast, the inclination to flow out in the direction of the point where the tide wave comes from is very strong. This law of the *preferent outflow* of rivers and estuaries must be taken into account when improvements of mouths and inlets are being planned.

*Written in 1940, since then the survey-ships were destroyed by the Germans.

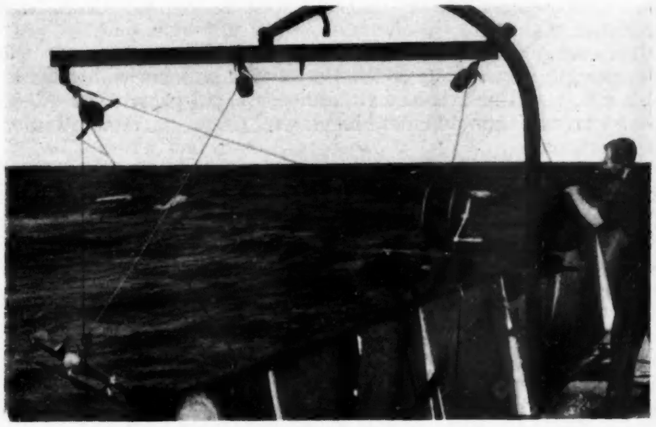


Fig. 7.—Ott Meter of 100 k.g. weight.

Current Meters.

The discharge of the tidal rivers is measured by means of floating sticks in alignments lying at distances of 30 metres from one another. The sticks are used as long as possible, but they must not touch the bottom. They are let loose from anchored boats lying in alignment at 6 to 15 points of the breadth of the river. The measurements are taken during a whole tide between two slack-waters, the floats giving the velocity every 5 or 6 minutes. Once in about 15 years the capacities of the tidal rivers south of Rotterdam-Dordrecht are determined in this way, because many changes are taking place there. Comparison with former flow measurements show the changes brought about in the water movements by dredging, etc. These observations are taken with the greatest care and accuracy, while many gauges are being read every five minutes at exactly the same moment. With these accurate measurements, the theoretical tidal formulæ are compared and the constants of de Chezy fixed for every channel.

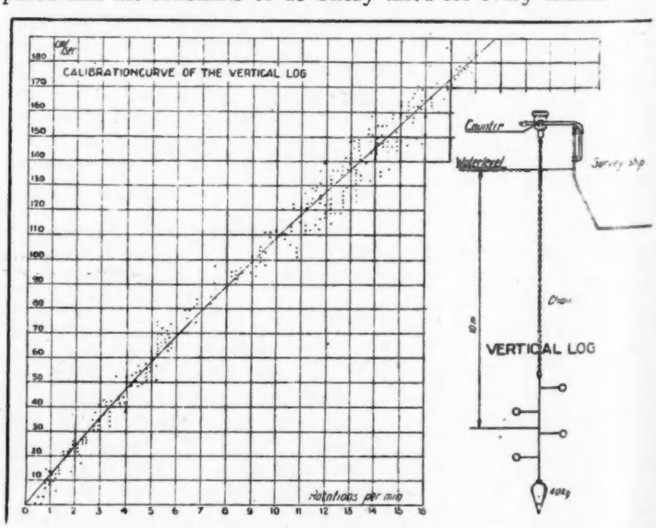


Fig. 8.—Vertical Log of Dr. Carruthers.

Research of Tidal Rivers in the Netherlands—continued

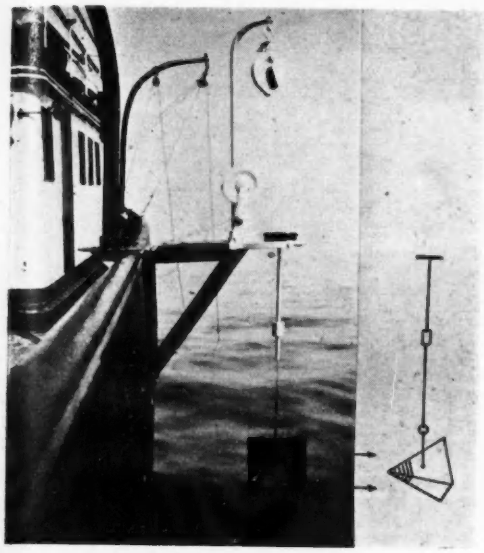


Fig. 9.—Current Direction Meter.

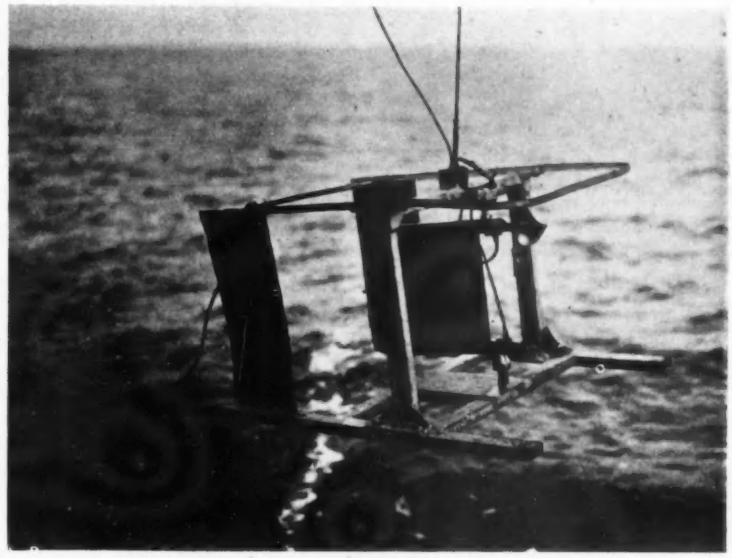


Fig. 10.—Bottom Current Meter (Double).

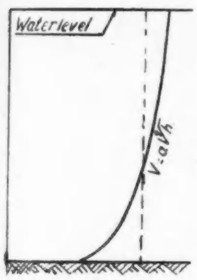


Fig. 11.—Stream Vertical (Parabola)

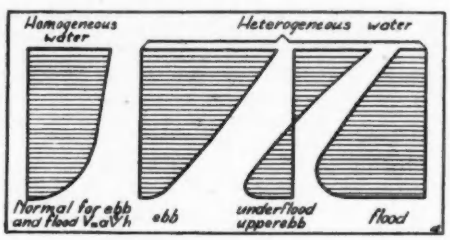


Fig. 12.—Stream Vertical (Heterogeneous Water)

For ordinary current measurements taken from exploring ships, Ott meters are in use (Fig. 7), weighing from 50 to 100 kg. With the Ott of 100 kg. it is possible to work at a depth of 70m and a mean velocity of 2 m/sec., but this is the limit because the electric cable cannot bear too strong a tension. The current meters must be very heavy to resist the pressure of the streams.

Carruthers' Vertical Log.

A good instrument which stands all weather conditions and which is easy to manipulate was designed by Dr. J. N. Carruthers, now of the British Hydrographic Department (Fig. 8). As it lends itself admirably for continuous measurements, the Dutch light-ships are provided with it. It is suspended on a chain outboard the ship and turns slower or quicker owing to a weaker or stronger current. A counting device near the point of suspension is read off every half-hour. It has the advantage that the turning device is above the water and that observations can also be made during a gale.

Current Direction Meter.

The Ott does not give direction. For finding direction at different depths, the Jacobsen principle is used (Fig. 9). Pyramids of different sizes, hung with the point towards the currents, give

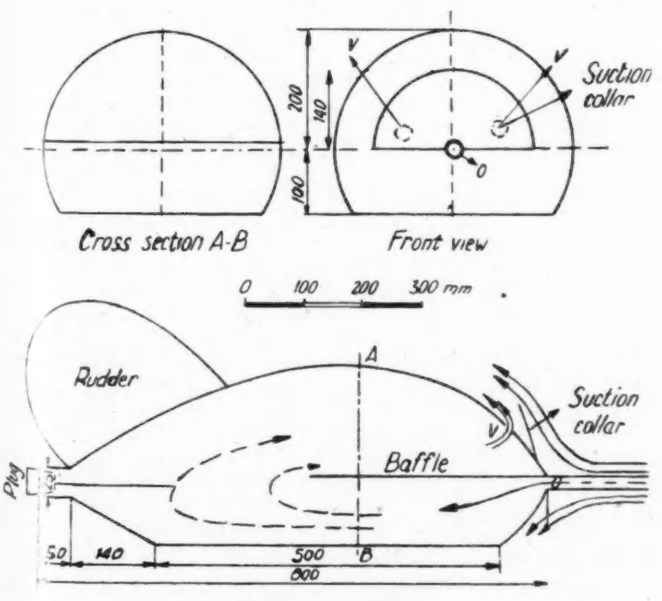


Fig. 13.—Sand Catcher.

Fig. 13a.—Sand Catcher Direction Meter.

Research of Tidal Rivers in the Netherlands—continued

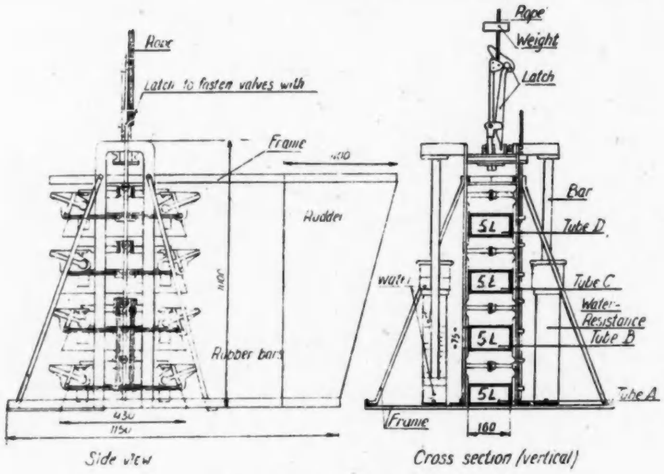


Fig. 14.—Sample-Taker.

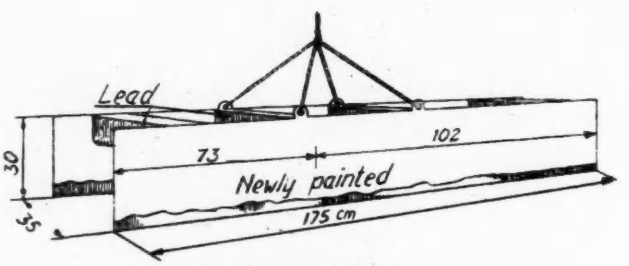


Fig. 16.—Ripple-Meter.

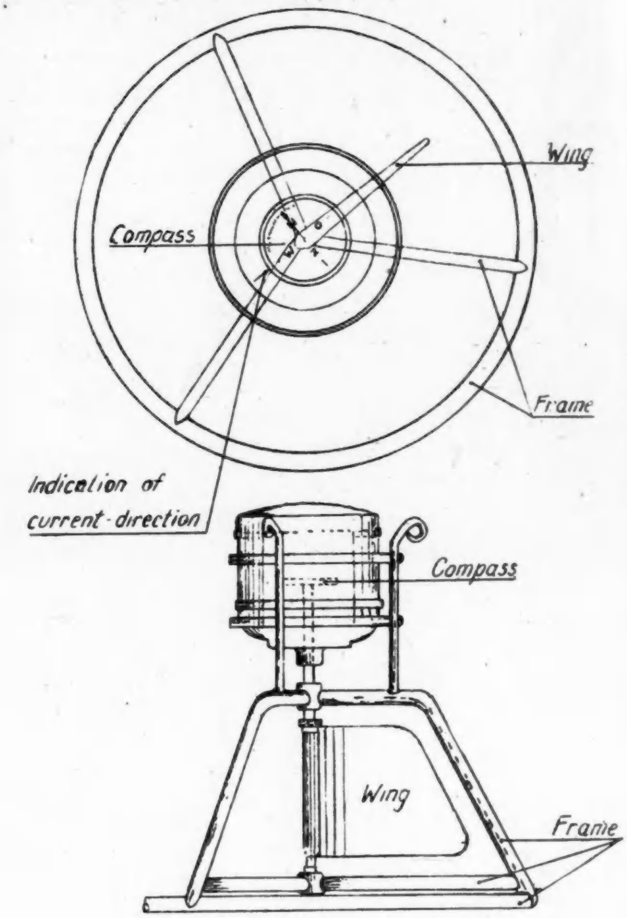


Fig. 15.—Bottom Current Direction Meter.

a slant which is measured by a bubble. We use pyramids because they do not wobble in the stream. Carruthers' vertical log may be used in the same way, so that this instrument gives the direction as well as the velocity of the current.

Bottom Current Meter.

Also an instrument for measuring bottom currents, system Ott (Fig. 10), possessing two propellers, one at 15 and the other at 50 cm above the bottom, is used. It is placed on the bottom during whole tides. Each half-hour current verticals are measured with the aid of an Ott current meter. We have found from thousands of old and new accurate observations that these stream verticals can be very well approximated by the formula $V = a\sqrt[q]{h}$ in which V is the velocity of the current, a is the velocity at 1 m above the bottom, and h the height above the bottom. For the sea, q varies between 4.8 and 4.9 (Figs. 11, 12). In rivers and inlets, $q = 5$ to 7. It is not right to suppose that the velocity graph intersects the bottom.

Sand Catcher (Canter Cremers).

The mixture of water and sand flows through the narrow opening of this apparatus into the hollow interior and comes to rest there (Figs. 13 & 13a). The water flows out of the instrument behind a suction collar through holes which are gauged in a laboratory in such a way that the current enters " O " in a straight line. Silt is retained in the apparatus, as " O " is narrow in proportion to the hollow room inside. The accumulating action prevents the fluctuations of the sand transport being studied with this instrument. Only the sand in suspension can be measured, not the rolling sand. The smallest height above the bottom where measuring is possible with this instrument is 10 cm. The apparatus is used on light-ships continuously, being emptied at every slack water—that is, once in about 6 hours.

Sample Taker.

The water flows freely through one or more short, wide, square tubes, which can be closed suddenly by means of two valves with rubber springs. In this way, four samples of 5 litres are taken at 0, 20, 40 and 60 cm. above the bottom and these can be examined carefully with regard to the contents of silt and sand. Instead of four, two or one tube can be used. The short tube, or set of tubes, are lowered very slowly by means of water buffers to the bottom, till the undermost tube rests immediately on the bottom. The rolling sand and little sand waves can therefore enter. Usually some small distance above the bottom is taken as the lowest position because general comparison is mainly what is wanted. The amount of sand and silt in the samples of 5 litres is always sufficient for accurate measurements. In the tidal area the sand usually whirls up to a great height. Besides the percentage of sand and silt, the salinity of the bottom sample can also be measured, as well as the temperature. The sand catcher (Canter Cremers) and the sample taker (Fig. 14) are used alternately for mutual checking.

One of the most important results of the investigation with sand catchers is the discovery of sandless areas. These exist in the rivers between Rotterdam and Willemstad—covering a breadth of about 10 km. (see Fig. 1)—in the Straits of Dover and in some places in river bends. These sandless areas point to a discontinuity of the sand currents and are very suitable for harbour works.

Direction of Bottom Currents.

As mentioned, the current direction is measured by means of the Jacobsen (see Fig. 9). This apparatus is not thought suit-

Research of Tidal Rivers in the Netherlands—*continued*

Fig. 17.—Grab.

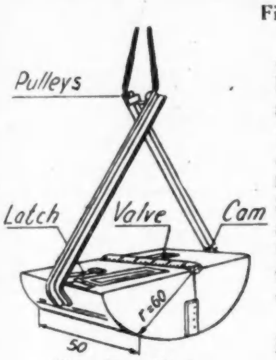


Fig. 17a.—Grab.

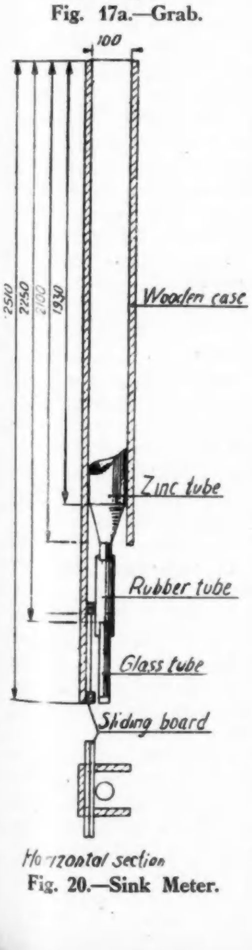


Fig. 20.—Sink Meter.

able for measuri:.g the direction of bo.tom currents. For this a more accurate instrument is shown in Fig. 15, based on the following principle. A watertight box contains a magnetic needle which is fixed by a clock after 3 minutes. Because the box as well as the clock are made of brass, and the box is not kept closer to the ship than 30 m., the readings are trustworthy.

Ripple Meter.

A simple but good device used to determine the ripple-shapes on the bottom is shown in Fig. 16. The two plates are painted with fresh paint beforehand and the bottcm sand sticks to this moist surface, so that the shape of the bottom can be clearly seen. By a slightly eccentric suspension, the plates turn into the direction of the current, which always is perpendicular to the ripples. The form of the ripple profile gives the direction of the prevailing sand movement.

Grab.

The existing grabs were too small for our purpose or did not shut properly, so that a new model was made (Figs. 17 and 17a). It is scissor shaped and has pulleys over which runs an endless steel cable, on which the grab hangs. When opened, a latch prevents it closing. As soon as the grab touches the bottom, the latch falls out by its own weight and the grab closes before being pulled up. This grab rarely fails and is to be recommended.

Ramming Drill.

In order to penetrate deeper into the bottom, a ramming drill was made (Fig. 18). A tube is placed on the bottom and rammed into it to about 1 metre depth. Often we find some clay quite close under a thin layer of sand, or sand and silt in alternating layers.

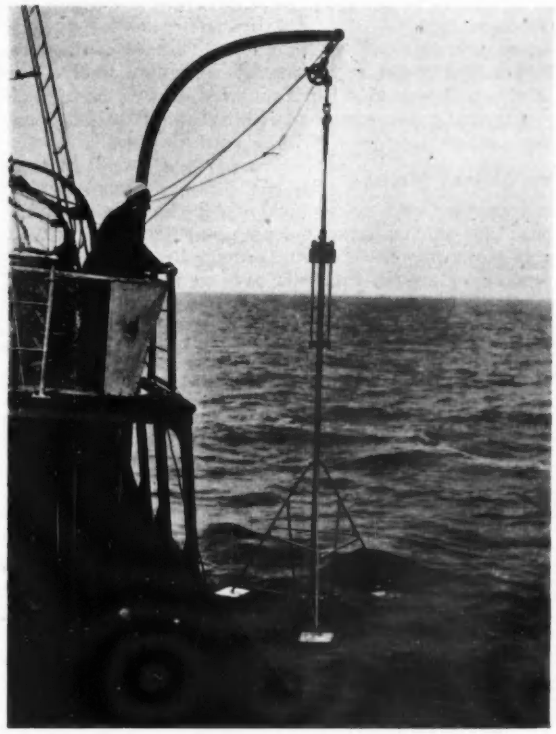


Fig. 18.—Ramming Drill.

Borings.

A still deeper penetration into the bottom is possible in good weather by executing pulse drilling with tubes of 10 cm. diameter. When the currents are too strong and the depth is too great, the tubes snap. Usually we do not reach a greater depth than 8-12 metres below the bottom surface (Fig. 19).

Sink Meter.

The size of the sand grains is determined with the aid of a pipe of 2.50 m. length, in which water is kept (Fig. 20). When throwing some sand into it, the coarsest sand grains fall quickest through the water. A chronometer gives the exact time of settlement of the different layers which gather in the glass tube at the lower end. The accuracy reached with this very quick method is thought to be greater than with sieves. The temperature of the water

Fig. 19.—Boring in the Sea.

Research of Tidal Rivers in the Netherlands
(continued)

through which the sand settles must be known, because it has a great influence upon the rate of fall (Stokes law). Salinity has only a small influence. Determination of silt percentage is more difficult than that of sand, because silt settles so slowly. A filtering apparatus with a suction device is used, but we prefer a simpler way by comparing the samples with those of suspensions of a known percentage.

Recording Salinity Meters.

Because of the serious effect salinity has on horticulture and agriculture, several registrating and non-registrating instruments are in use, measuring the salinity through the electrical resistance of the water. These instruments give good results for the low salinities in which we are interested. The salinity lines of 300 mg. Cl per litre are fixed daily at high water slack tide by means of portable "dionic" instruments.

Research and Planning.

The research bureau gradually and quite naturally became a planning bureau. The engineers in charge of the research were also in charge of a certain district, where they did the daily work such as the making of new contracts, etc. Therefore the connection between theory and practice was good. It was found that research leads to planning, and that planning without research and study cannot have the best results.

Tyne Improvement Commission

Chairman's Address at Annual Meeting

At the Annual Meeting of the Tyne Improvement Commission held on the 19th November last, **Mr. W. A. Souter,** who was first appointed Chairman of the Board in November, 1945, was unanimously re-appointed to that position, and the re-appointment of **Mr. Alfred Raynes** as Deputy Chairman was also confirmed.

Acknowledging his appointment, Mr. Souter said:—

I regard it as a very great honour to have been re-elected as Chairman of the Tyne Improvement Commission for another year. It gives me the opportunity of continuing the great work which has already been carried on by my predecessors on the River Tyne which is of such great importance to the welfare of Tyneside as a whole. Considering that our annual expenditure exceeds a million pounds and that we will handle this year nearly seven million tons of exports and imports it is also a great responsibility.

In view of the big programmes of development announced by our near neighbours there has recently been some criticism that the Commission is not putting forward anything of a similar nature. The fact is, however, that we do not need to embark upon a costly addition to our facilities. Owing to the continuous development of the Tyne which has been going on for a great many years, we now possess a waterway suitable for deep sea vessels at high or low water for 15 miles of its length, and with dock and quay accommodation fully equipped for the present volume of trade or for any probable increase for many years to come.

The capital cost of our undertaking stands at 8¾ millions stirling; its value can be put far higher than that figure because in addition to the capital cost we have spent in the past about £10,000,000 out of revenue at a time when costs of construction were much less than they are to-day. To-day our outstanding debt is only £3,332,975.

We have to thank our predecessors for making wise provision for the annual redemption of debt. This redemption of debt is continuing each year, and we can look forward to the time when the annual charge for redemption and interest will be so reduced that we can eventually make a substantial reduction in dues.

I think, therefore, you will agree that it would be wrong and wasteful at the present time to go in for any large scheme of port development which is unnecessary. We are, however, continuing to improve our properties and increase our facilities for the quick turn-round of vessels and the handling of cargo. In the past year we have repaired and strengthened "A" and "D" Staiths in Tyne Dock so that they will give good service for many years to come. We have spent over £10,000 in providing 307 more wagons for use at our docks; we have bought two locomotives for use at Albert Edward Dock at a cost of £11,200, and we are providing three additional electric cranes at Albert Edward Dock at a cost of £26,000. I am glad to report that our Norwegian trade is reviving, and I hope before long it will attain its pre-war volume. Our import trade of timber and iron ore is also showing a considerable increase.

The chief problem is to increase our export trade, and particularly our export of coal. That is of great importance in itself, and also because it would mean a further increase in our import trade. The Scandinavian countries in particular cannot send us an adequate quantity of the imports we require because we cannot send them coal. We are shipping more coal than last year, and it seems probable that this year we will ship more than 6 million tons, which is 1 million tons more than last year. Unfortunately very little little of this coal is going abroad; so far this year 92 per cent. of our shipments are coastwise, and we are shipping less abroad even than we did last year. No concessions in dues would help even if we could afford them, and we are prevented from reducing dues because of the small quantity of coal shipped, which, as you know, is considerably less than half what we shipped before the war.

I am not a pessimist regarding the coal position; I believe that the supply of coal which we need will eventually be forthcoming because the coal is there. At present the demand is there also, and I can only express the hope that when the coal is forthcoming the demand will still be there, because it is quite certain that our customers abroad, whose need now is so great, will develop their own coal mines and hydro-electric power to the maximum possible extent.

Regarding coal, I venture to make this observation:—

Among the ample coal resources of this locality, we have at our doorstep perhaps the finest quality of coking coal in the world; its supply, however, is not unlimited—I understand it is likely to last about 60 or 70 years. That should be sufficient for us and for our grand-children. Between the two wars we have exported to the Continent—much went to Germany—large quantities of this coking coal at prices and at rates of freight which left no profit to the collieries or to the British ships which carried the coal. On the Continent this coal was converted into coke with its valuable attendant by-products, and was then largely used for making iron and steel. I think it would be much better for Tyneside if this valuable coal were used more on Tyneside. If it were, there would be several advantages; we would have the benefit of the by-products; our iron and steel industry locally could be expanded, and we would have a surplus for export, and there would be additional employment for men. We have the facilities and the depth of water to discharge the largest ore-carriers.

If our coal shipments are not going to increase beyond the present figures, we must look for alternative sources of revenue. At the present time the Newcastle and Gateshead Chamber of Commerce is conducting an enquiry as to the quantity of cargo available locally which would encourage liners to come to this river. The Tyne Commission welcomes that enquiry, and is assisting actively in helping to obtain the required information. I do not wish to anticipate the result of this enquiry, but I think it is probable that it will disclose that although there is a considerable quantity of liner cargo which could be shipped from the Tyne it is not sufficiently large to attract liners without the addition of substantial quantities of heavy cargo. Liners are coming to the river now for our shipments of sulphate of ammonia, but this is only for certain destinations and the quantity available is not sufficient to attract liner traffic generally. We require a considerable addition in the weight of our exports of general merchandise and as I have indicated, I think the most likely source from which this could come is from iron and steel.

We welcome the new industries which are being started in the neighbourhood, and I would like to thank the different riparian authorities for their efforts in this direction; I would like specially to mention Tynemouth which has shown such praiseworthy enterprise in this direction. These are, however, only light industries,

Tyne Improvement Commission—continued

and it appears unlikely that they will add a great deal either to our imports or exports on the river.

Some time ago an announcement was made that the Government were going to take over ports and harbours. It may be that this question will be dealt with under the terms of the Bill mentioned in the King's Speech to bring inland transport under national ownership. We must just wait until the provisions of this Bill are announced; however, I would like to repeat what I expressed earlier in the year, namely, that I hope that the constitution of trust ports such as the Tyne Commission, will be allowed to continue.

In conclusion, I thank you once more for my re-election; it is a pleasure to be Chairman of such a body as the Tyne Commission where such a harmonious spirit prevails in our deliberations, and where the team spirit is so strong. I think this feeling is natural because we are all imbued with one desire, and that is, to promote the welfare and trade of the Tyne and Tynside.

Generally, I think we can look forward to the future with confidence; our financial position is excellent; our trade, although still far below pre-war figures, is increasing and I believe will continue to recover its position.

Legal Notes

Stevedore's Claim for Personal Injuries

In an action heard before Mr. Justice Morris, in the King's Bench Division recently, Mr. James Butler, stevedore, aged 50, of Bestwood Street, Deptford, sued the Hogarth Shipping Co., Ltd., of Vincent Street, Glasgow, claiming damages in respect of personal injuries he received. The hearing lasted several days and concluded in favour of the plaintiff.

Giving judgment, Mr. Justice Morris said that on November 24th, 1944, Mr. Butler was working on the unloading of timber from the defendant's ship, *Baron Haig*, in Surrey Commercial Dock. He was in a barge on the port side of the ship and was assisting in receiving timber lowered from the ship. A winch in the ship was being used, and the timber in the sling weighed about 25 cwt. The winchman had given evidence that, when he received a signal, he took the normal action to stop the descent of the load but found that he could not stop it. The set continued to go down, and some of the timber struck and injured the plaintiff.

In the pleadings there was raised the issue that the plaintiff was either solely or partially responsible for the accident, but no argument was addressed to his Lordship in support of that plea, and he was satisfied that it could not successfully be asserted that the plaintiff was in any way blameworthy. On the issue as to liability, many matters concerning the sequence of events and the performance of the winch were explored and debated. On behalf of the plaintiff it was contended, and on behalf of the defendants it was denied, that the evidence showed that the accident resulted from defects in the winch. The defendants urged that the accident was caused by negligent operation of the winch by the winchman, and it was common ground that if that were so the defendants would not be responsible for such negligence. If it were held that the accident resulted from defects in the winch, it was contended by the plaintiff, and denied by the defendants, that the facts showed that it was negligence by the defendants to have permitted the defects to have existed or continued to exist.

There was substantial agreement between counsel as to the legal duty owned by the defendants to the plaintiff. The defendants invited him to take part in operations in the ship and in proximity. It was for them to provide winches in working order, and the stevedore could not be expected, nor were they expected, to test, examine or repair the winches. There was a duty on the defendants to take reasonable care to see that the winches were in a fit condition to take the weight of the contemplated loads.

In considering the circumstances and the measure of care required, it was appropriate to remember that all concerned knew that the winches would be used in connection with the suspension of heavy loads over men working in the barges, and that peril to life and safety would be involved if winches became or remained in a dangerous condition. There was some conflict of evidence as to whether battens were fixed to the winch in question, and his Lordship had come to the conclusion that wooden battens were fixed, but he did not consider that that circumstance established that the winch was defective or dangerous. He was satisfied that winches which could be operated with safety were often to be found with wooden battens on them.

From April to September, 1944, the *Baron Haig* was being repaired at Greenock, and the winches were then overhauled. When the accident took place, the winch did not completely run out but stopped as soon as the set landed. There was no indication of any over-run on the set, and that suggested that the winch was not out of gear. If it had become out of gear, the wire would probably have run off and would have continued descending into the barge.

After the accident, some of the ship's officers went on deck, and the foreman stevedore walked to the winch and picked a cod piece off the base. The cod piece was obviously very much worn, and it showed wear described by one witness as " wear in extreme or fantastic stages." Another witness said that the cod piece was in such a condition as to make it apparent that it had been exposed to climatic conditions, and was not in the condition one would expect if it had fallen from the winch on the day of the accident and had been indoors ever since. When the ship's officers went on deck there was considerable argument. The foreman stevedore had formed the view that the winch had run out of gear, and when he found the cod piece he was confirmed in that opinion.

It was natural in the circumstances that he should have directed the attention of the ship's officers to the suggestion that the winch had gone out of gear. The officers looked at the winch to see whether it was then, or might recently have been, out of gear, and they examined the winch with that idea in their minds. Evidence had been given that a cod piece was fitted to the winch, but later it was found that the winch would not raise a set.

" The conclusion I have formed," said the Judge, " is that the accident happened because the winch, though used in a normal manner by the winchman, failed to operate. It was because of the state of the winch that the set was not held. It was not, in my view, because the winchman failed properly to operate the winch. I do not consider that the winch went out of gear, but I accept the evidence that work was done by way of fitting a new cod piece or removing one of those in position and grinding it down. The evidence shows that the cod piece was to some extent in need of alteration, repair or adjustment. It is to be noted that the evidence was that a new cod piece should be capable of being used for 500 working hours. The evidence establishes, in my view that one cylinder was out of action in the sense that the power from it was not being applied or harnessed, and the winch became incapable of raising or holding a normal load.

" It is not sufficient for the plaintiff merely to show that the winch failed. He must also show that the defendants did not fulfil their duty to take reasonable care to see that the winch was in proper and safe condition. There is no reason to think that the failure of the winch would arise suddenly, or that such a failure would occur less than one-and-a-half hours after the morning's operations had begun without some indication of trouble or possible trouble being apparent if reasonable supervision of examination had taken place."

The defendants had not sought to explain the breakdown of the winch as having been caused by some unexpected or unavoidable reason. Their case was that the winch did not break down and that on the day of the accident it was not altered or repaired. " In my opinion," added his Lordship, " it did break down, and was then repaired. I think the reasonable inference is that the breakdown could have been avoided if ordinary and reasonable inspection, supervision and maintenance of the winch had taken place. By reason of its condition, the winch became incapable at the time of the accident of proper mechanical control. The evidence leads me to the conclusion that reasonable care to see that the winch was in a fit condition to be used in operations fraught with hazard could not have been taken."

Holding that the plaintiff was entitled to succeed, the Judge entered judgment for him for £1,897, with costs.

A stay of execution pending a possible appeal was granted.

Use of the Cement Gun in Maritime Operations

Cement-Gun Repairs to Maritime Reinforced Concrete Structures, with Special Reference to the Town Quay, Southampton*

By JOHN PERCIVAL MASTERMAN PANNELL, M.B.E., Assoc. M. Inst. C.E.

(Continued from page 280)

Discussion *(continued)*

Mr. J. E. G. Palmer observed that the Author had stated: "Gunite is, therefore, a concrete having virtually zero slump." Mr. Palmer preferred to think in terms of the water/cement ratio, and he believed that a zero slump corresponded to a water/cement ratio of 0.45. He considered that it would be very difficult to measure the water/cement ratio of the gunite as deposited, but if the Author had made such a measurement, it would be interesting to learn the figure that had been obtained.

He wished to congratulate the Author on the fine set of photographs that he had obtained in very difficult circumstances. Fig. 6 showed a raking strut with the whole of the concrete cut right through and just the four bars remaining at the construction joint. How had the Author set about guniting that completely blank space

On a job carried out by the Admiralty, on a jetty near Portland (he did not know whether it was the jetty to which Mr. Morgan had referred), the gunite repairs were started in 1934, but the system was given up because it was found that so much of the old concrete had to be cut away, and the damaged parts of the jetty were eventually rebuilt completely. A considerable area was, however, covered before the system was abandoned, and the cost worked out at 5s. per sq. ft. of gunite.

Mr. Treharne Rees raised the question of the waste due to rebound. In the case of a concrete oil reservoir near Rosyth it was found that the loss of aggregate due to rebound amounted to 25 per cent.

Another repair job was at the Crombie jetty, which was built in 1915 from a good quality concrete, but there was only ⅝-in. cover to the stirrups, so that repairs had to be started about 1920. For many years the method of repair adopted was to cut away and re-concrete, a granite aggregate being used. The cover given was 2½-in., and the work was first class. In 1938 and 1939 repairing with gunite was started, 2-in. of cover being given, and that work also was first class. The density, however, was 10 per cent. less than in the case of the former repair, the reason being, he thought, that in the former case a granite aggregate was used and in the latter case only sand. The gunite work had been done for only six years and it was considered to be too early to judge whether it was successful or not, because the protection which the gunite had given was possibly due to a very fine hard surface finish, and the old reinforcement at the back might still be rusting.

Mr. A. S. Grunspan observed that he had had a good deal to do with certain land structures—bunkers and water towers in rather exposed positions—which had suffered a fate somewhat similar to that of the structures illustrated by the Author. A bunker 114-ft. in height, in a colliery, was subjected to sulphur fumes and moisture, with the result that it got into a condition similar to that described by the Author, and in some places even worse, because some of the bars of the columns had buckled and the links surrounding the column bars were completely eaten away. The method of repair adopted was to cut away the bad concrete and insert new links in two halves U-shaped, in addition to new vertical rods.

The columns were 30-in. by 27-in. In addition to the above, on one of the faces, where the concrete had not been so badly damaged, a fabric of a specification similar to that given in the Paper was dowelled to the concrete. A very satisfactory job had been made of the repair. On enquiring how long the structure had been in the state in which it was found just before the repair was carried out, he had been told that it had been so for some considerable time. In contrast, a water-tower on which work was started at a very early stage of the deterioration had needed very little repair.

Preparation was very important. There was a tendency to be satisfied with too little hacking; but Mr. Grunspan considered that the concrete should be very carefully hacked and in some cases re-hacked even after the fabric had been erected, whilst it should be very carefully cleaned. The most important point was to get the rust off.

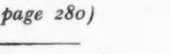


Fig. 15.

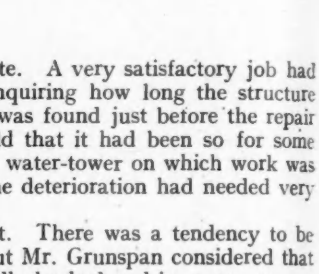


Fig. 16. Ollard's Adhesion Test for Electro-Deposited Metals

One lesson to be learned from the failures which had occurred was that it was advisable to design the column with the core to take the full load, without any cover.

Mr. R. P. Mears observed that apparently the trouble in the piles and beams occurred at the corner, and the tendency was for concrete to shrink round a bar—especially a large bar—causing the initial trouble, which frequently developed afterwards.

One hardly ever saw an octagonal pile; yet an octagonal pile could contain any number of quite small bars, which were much better than large ones, and there were no sharp corners. Would the Author recommend octagonal columns in place of square columns?

Trouble seldom arose in the slab itself. As a rule there were no longitudinal cracks under slab reinforcement, but cracks usually developed at beam corners. Why should not a beam be concreted at shown in Fig. 15, and have no sharp corner?

Mr. T. W. Moran observed that the defects described in the Paper were similar to those which he had seen in other cases, whilst the vertical range of defects on piles and braces was also similar, namely, extending downwards 5-ft. to 6-ft. below high-water-mark. The soffits of deck beams sometimes suffered more severely than the pile bents and it might be advantageous, in new construction, to form the soffits sloping slightly to one side with a small drip projection, instead of making them horizontal with chamfered edges. In general, provided that the steel reinforcement had adequate cover of dense concrete, deterioration was unlikley to occur, but it would seem to be well worth while to give new maritime reinforced concrete structures a coating of tar as an additional protection.

Corrosion of the reinforcement sometimes began through pieces of binding wire being left exposed, and steel fixers should be trained to go over their tie-wires on completion and turn all ends inwards. As a further precaution, Mr. Moran had for a number of years used one of the brands of "rustless" binding wire which were on the market.

A type of defect which was frequently found in the older reinforced concrete jetties of rigid design without raker piles was the fracture of the front row of piles at the level of the lower horizontal

*Paper read before the Maritime and Waterways Division of the Institution of Civil Engineers and reproduced by permission.

Use of the Cement Gun in Maritime Operations—continued

bracing. Adjacent diagonal bracing might be similarly fractured. That damage arose from the impact of ships coming alongside at too high a speed. Repairing or re-casting the damaged members afforded no guarantee against recurrence of the trouble, and it would seem advisable in such cases to introduce some form of spring fenders or suspended fenders to absorb the impact stresses.

There could be no doubt that the cement gun provided a suitable method of repairing the type of damage described by the Author, provided always that a high standard of workmanship was secured. Mr. Moran had seen several attempts to repair such defects by rendering or re-casting with poured concrete, but in each case the repairs had failed.

He considered that the type N.2 cement gun was rather large for the kind of work described and a slightly small size, for example, type N.1, or its equivalent in other manufacturers' machines, would be more convenient and would impose less strain on the nozzle operator; the spray would also be of more manageable dimensions, particularly if an extended nozzle were used so as to give more confined spray cone. A marked advantage was obtained by fitting a moisture separator on the air line to prevent condensed moisture from entering the cement gun and causing premature hydration. The separator also extracted condensed oil from the air.

The water supply to the nozzle was taken direct from the mains in the works described. That was not always advantageous, as main pressures might fluctuate when other parties were drawing off water. It was desirable to have the water pressure at the nozzle a constant amount higher (say 10 to 15 lbs. per sq. in.) than the pressure used in the cement gun. That enabled the nozzle operator to exercise more effective control over the quantity of water admitted for hydration. The water supply would be drawn from pressure tanks coupled directly to the air compressor manifold.

When using pneumatic chipping hammers it was preferable to operate them at a pressure of not less than 90 lbs. per sq. in. The efficiency of the tools decreased considerably at lower pressures and, if the quantity of work to be done was considerable, the use of a separate air supply for the pneumatic tools might be justifiable.

In exposed waters Mr. Moran had carried gunite repairs down to half-tide level without damage by wave action, and in sheltered tidal waters to within 1-ft. or 2-ft. of low water of spring tides.

The selection of fabric reinforcement was important, as it was desirable to have a material which could be bent accurately and positioned accurately so that the ultimate cover would be as specified. A hard-drawn steel wire fabric fulfilled those requirements better than a mild steel fabric. A heavy material was usually not necessary, and in most cases a 3-in. by 6-in. mesh of 8-gauge wires would be found adequate.

The Author had emphasised the need for elimination of all cracked or defective concrete and the cleaning of reinforcement to a mill surface. Mr. Moran doubted whether the latter was really essential. The removal of all loose rust or scale was absolutely necessary, but it was not essential to clean down to bright steel, as was occasionally specified. If a steel bar were thoroughly encased in a dense material with adequate cover, so that both moisture and atmosphere were excluded, corrosion would not continue. A third essential in preparation was the roughening of any smooth concrete surfaces so as to provide a key. Open picking was insufficient and really close hacking was desirable. The ideal preparation was bush hammering, but that was rather slow and costly. Wet sand-blasting, as described by the Author, was useful in certain cases, it was more efficient than wire-brushing, but inferior to bush-hammering. Wet sand-blasting with ordinary concrete sand and with pressures in the neighbourhood of 30 lbs. per sq. in. gave results inferior to those obtained in workshop practice with very sharp flint sand and higher pressures.

In the application of gunite, the present-day tendency was to use pressures rather higher than 25-30 lbs. per sq. in., and appreciably better results were secured with pressures in the 35-40 lbs. range: pressures of up to 70 lbs. per sq. in. had been used with good effect.

The danger of pockets of rebound occurring was real, but it would be minimised by a thoroughly skilled nozzleman and by maintaining a high level of supervision.

Mr. Moran concurred with the Author that a cover of 1-in. of well-deposited gunite formed an adequate protection against sea-water; but it was very desirable that that cover should be 1-in. in the clear, and that no odd ends of steel fabric or pieces of binding wire should be left projecting. He considered that it was better practice to build up the thickness in coats not exceeding $1\frac{1}{2}$-in. on vertical work and not exceeding 1-in. on over-hanging work, than to attempt to supply a thickness of 2-in. in one operation. In one method of ensuring adequate cover and avoiding rebound, the member under repair was first thoroughly cleaned and all disintegrated material cut away, and the surface was thoroughly roughened. The wire fabric was then fixed in position and spaced about $\frac{1}{2}$-in. off the original surfaces, being bent to shape and size, with sharp corners, on a bench. Light timber profiles, say 3-in. by 1-in., were then fixed in position on the four corners with their edges $1\frac{1}{2}$-in. away from the original surface of the concrete. Two opposite sides of the member were then gunited up to $1\frac{1}{2}$-in. thickness. When the gunite had hardened the profiles were removed and the work was inspected. If any sand pockets existed they were cut out and filled up with gunite. After the work had set a final coat of $\frac{1}{2}$-in. was applied all round. That procedure gave a rather squarer finish than that shown in Fig. 8, and it had the advantage of ensuring adequate cover everywhere.

With regard to the working organisation and the personnel employed, much more rapid progress would probably be made if six or eight men were allocated to cleaning the old work and fixing reinforcement in advance; otherwise the cement gun would be operating intermittently and the costs would be increased. Output and quality alike depended upon team work in the gang and a good foreman was essential for that purpose. Repairs of the type described entailed, if successful, doubling the life of the structure at a fraction of the cost of reconstruction, and a high standard of engineering supervision, with constant insistence on quality, was desirable. Concentration on good technique alone would not secure the best results.

Most foremen, inspectors and clerks of works were accustomed to handling concrete or mortar when placed with the shovel or trowel. When using the cement gun it was necessary to appreciate that a new medium was being employed, and that the mixture was not being placed by any form of hand tool, but the individual particles were being conveyed in suspension in a fast-moving current of compressed air. If the stream of particles were handled in the wrong way, air-eddies might be set up where the blast impinged on the treated surface, and bad work might result. If, however, the characteristics of that method of applying concrete were appreciated from the outset, it was possible to produce repairs of a standard superior to that obtainable by other means.

Mr. C. A. Wilson observed that it would be generally agreed that the use of the cement gun as a method of repair for brick and concrete structures was effective and was becoming increasingly common. As a rule, if the work were carried out by contract the price tended to be high where traffic or other conditions did not permit of a straightforward job. The Author was to be congratulated on his decision to purchase the necessary plant and employ direct labour. On the costs given, that appeared to show a substantial saving on contract prices of more than 100 per cent.

The method employed appeared to conform to standard, with the compressor having a good margin of reserve pressure, which was reflected in the absence from breakdown; the working details were interesting and should be extremely useful as a guide where direct labour was employed.

In Fig. 12 the operator seemed to be wearing a special type of cap and goggles, although the latter were not in position: was their use necessary when working in confined situations, and were any ill-effects felt by the nozzle operator at any time

In quay traffic operations, presumably there was vibration from the cranes and wagons, and possibly from other vehicles. Had that caused any ill-effects on the work, either during execution or after?

Mr. Wilson had used the cement gun process for repairs to brick-arch bridges and aqueducts since 1934, and in all cases the work done was as good as when the repair was first carried out.

Use of the Cement Gun in Maritime Operations—continued

The Author, in reply said that his principal object in presenting the Paper had been to tap the combined knowledge of other people who had had experience of gunite work, in order to be able to start his post-war gunite programme a stage ahead of his original work. As a result of the very stimulating discussion which had taken place, he felt that he would be able to avoid some of the pitfalls into which he had fallen in the past.

He was extremely interested in the question of bond, to which Mr. Morgan had referred, and he was endeavouring, in conjunction with University College, Southampton, to carry out some tests on the bond strength of gunite. For some years he had been trying to develop a suitable test-piece, and some time ago he had seen a design of a test-piece[1] for testing the bond strength of electro-deposited material, where a bond face was built up by electro-deposition in the manner shown in Figs. 16 (reproduced by permission of the Institution of Mechanical Engineers).

In that method a cylindrical test-piece was " stopped-off " with wax; a minimum thickness of about 0.1-in. of nickel was deposited on the exposed end; the wax was removed and the deposit machined; and the adhesion of the annulus of deposit was then determined in a testing machine by measuring the load required to detach it from the specimen.

He was developing an idea on those lines, whereby a moulded test-piece, not necessarily dimensionally similar to the one shown in Figs. 16, but something like it in shape, could have a reinforced gunite addition to it, so that by designing the test-piece to fail at the bond surface the approximate bond strength could be obtained. Comparisons could be made by breaking test-pieces cast throughout in one operation or with a cast bond surface. Tensile or shear results would be made by shooting on gunite in an appropriate form. There could be no question that the bond strength in gunite was very important.

A few timber piles at Southampton had been covered with gunite to make up for loss due to the action of *limnoria*, but very few timber piles there carried loads directly. There was a very large number of timber fender piles, but he considered that for fendering the timber should present its face plus any rubbing strip; therefore no timber fender piles had been built up. He could not see any need to build up greenheart piles with gunite, because at Southampton some greenheart piles 50 years old, in structures which were very subject to attack by *limnoria*, were still in very good condition.

He believed that electrolysis might possibly play a bigger part in the deterioration of steelwork than had been realised in the past. As a result of failures of steelwork through the proximity of other metals, he had carried out some tests and had found surprising potential differences in sea-water action on metals which were not very dissimilar in an electrolytic sense. A scientific study of the problem would be very profitable for all engineers engaged in maritime work.

He considered that the danger in using the heavy hammer was not so great as the risk of not getting off all the defective material, and, despite the warnings which had been uttered, he would continue to use a heavy hammer.

Mr. Carter had shown a construction at the edges such as that illustrated in Fig. 13, but, so far as the work at Southampton was concerned, there was so much to do that he could not slow it down for any such detail as that. For cutting away, however, he would in most cases proceed as shown in Fig. 17. The gun-spray was not a pencil-point spray but a rather broad spray, and one could not finish off as at F in Fig. 14. The gunite would overlap and there would be a flash-off possibly 6-in. in width. He wished to emphasise that the surface on which the flash-off came could be clean. If it were left in the condition brought about by the sea and oil, a good bond would not be obtained and cracking away would start at G (Figs. 17). The crack might not do any harm at the time, but future failures might commence to build up there. Mr. Carter had asked if the Author invariably exposed the whole bar before applying gunite. In the case of columns or struts the old material was cut away as shown in Fig. 18. That was usually done in two operations, guniting the first half before cutting the second. An exception to that practice occurred in the case of the Kahn reinforcement, which was in most cases only partially exposed. Such differences in method bore largely on the final remarks in Mr. Jackson's contribution in regard to the engineer's views on the methods to be adopted.

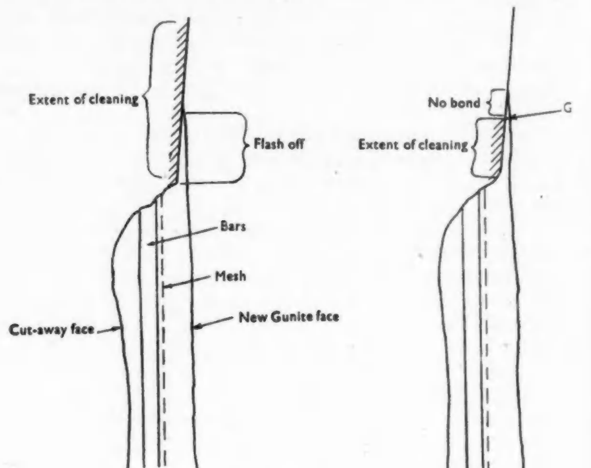


Fig. 17.

Mr. Jackson's description of the shooting strips was a useful addition to the technique. The value of 10,000 lbs. per sq. in. given in Mr. Pearson's Paper referred to cubes cut from the slabs built up with the cement gun.

The waste of material, to which Mr. Treharne Rees had referred, was a point which might be raised by people who were fortunate enough to do gunite work on dry land, but at Southampton the material went into the sea and helped to silt up the harbour.

If the sand used was completely dry, some waste of cement might occur. Before the correct degree of hydration was reached, a certain quantity of material might be shot on, and if the mix was very dry cement might be wasted. Also—which was more important—by the sea there was usually a breeze, and cement might be lost in the earlier operations. The question of the dryness of the sand was one in regard to which some degree of intelligent discretion might be used by the operators or the supervisor. As stated by Mr. Orr-Ewing, other than absolute dryness might lead to abuse, and in that connection some measure of control would be a help: whilst, if the sand was too damp choking would occur.

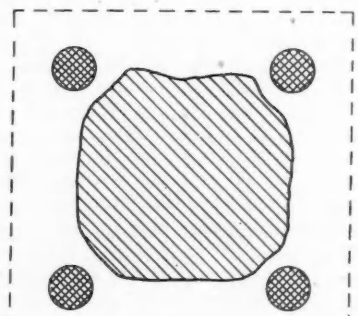


Fig. 18.

Mr. Orr-Ewing had also referred to the finish of the day's work. In that connection the Author was more fortunate in the work at Southampton, because the repairs there were to a large number of small individual units, and it was not necessary to start any work that could not be finished the same day.

He appreciated Mr. Palmer's favourable comment on the photographs. Most of them had been taken from a boat, the camera being held against an adjacent pile while the boat was bobbing

[1] A. W. Hothersall, "The Repair of Worn or Over-machined Parts by Electro-deposition." Proc. Instn. Mech. Engrs., vol. 152 (1945), p. 8 (June 1945).

Use of the Cement Gun in Maritime Operations *(continued)*

up and down and all hands were on deck, holding the boat to the pile, while a 30-second exposure was carried out. As an amateur photographer, he might say that the wastage of film in getting the photographs was greater than the wastage of sand in the guniting process.

In reply to Mr. Mears's question on shrinkage, he did not propose to enter the arena on that side of design, but he thought it possible there might be something in what Mr. Mears had said on the subject. There were no octagonal columns in the work at Southampton.

No tests had been carried out on the strength of members repaired at the Town Quay. Mr. Pearson's Paper included details of some interesting tests on full-scale structural members repaired with gunite.

In reply to Mr. Scott, the sand blasting of old work was invariably done with a water and air jet, no dry dust passed, and no ill-effects observed on the operators had been observed.

A number of joints between members had been cut away as shown in Fig. 6 and had been gunited by placing a "shooting board" in position as a shutter to take the first placing; gunite was then progressively built up from one side.

The Author agreed with Mr. Palmer that it was possible to find a structure so badly deteriorated that complete rebuilding was the only remedy. In such cases it was probable that damage by causes other than corrosion, for example, impact of shipping, contributed to the general deterioration.

Mr. Moran's remarks on preparation could not be too strongly emphasised. The bush hammering of the original face adjacent to portions cut away would ensure a good bond between the flashed edge and the old work.

Indian Ports and Food Supply

The Handling of a Crucial Problem

Among the post-war reconstruction problems which face the Allied nations a year after the cessation of hostilities, the problem of procurement of food is one of the most pressing, and for certain countries, more vital than all others. To the sub-Continent of India, where the ravages of war, but for a strip on her north-east frontier and a few small air raids on the East Coast, never developed to serious proportions, the spectre of famine and starvation, which gripped Bengal four years ago, and now stalks the southern half of the country and over 100 million lives, is a menace more serious and widespread than any in her long and chequered history.

Cereals—India's Main Food

To appreciate more fully the critical food position in India to-day, it should be realised that this vast dominion of nearly 400 million people, subsists very largely on cereals for food. Meat and vegetables, fish and poultry are minor considerations in any small household. Fifty-five million tons of grain, of rice, wheat, millet, gram and pulse, are required yearly to enable quite a large number of people to eke out a fairly low existence. But should a drought, a fitful monsoon, or the vicissitudes of Nature affect a large part of the country where one of these cereals is the main item of diet, no other zone produces a sufficiency of that grain to help the stricken province to tide over her difficulties. In the north of India where wheat is grown as a cold weather crop, this food grain is the common man's sheet anchor; in the sunny south, which looks to rice, millet and pulse, largely monsoon grown, for sustenance, wheat or barley make little appeal. The Northerner cannot do without his roll of bread or chappatti; in Madras and Mysore, no meal would be complete without a bowl of rice, flavoured or curried with lentils or vegetable.

Imports and Exports

To maintain therefore, a sufficient quantity of food for the peoples of the densely-populated southern provinces and adjoin-

Discharging Bulk Wheat.

ing districts, India imported before the Japanese invasion over one-and-a-half million tons of rice from Burma every year. She could also call upon the resources of Malaya and Siam in case of need. The development of irrigation in the Punjab, the United Provinces and Sind, with the successful operation of the Sukkur Barrage, gave these provinces a surplus of wheat. They were able to export over a quarter-million tons each season to the Persian Gulf, East Africa and the Middle East, after meeting all requirements inland. Large irrigation schemes have turned many a desert into a granary, smiling at both drought and flood, and fearing neither.

The Food Situation in 1942

The food position of India, before the loss of Malaya and Rangoon, with the easy availability of rice and wheat from other countries, should occasion arise, may be considered satisfactory. She could export both for the armed forces overseas and to other eastern allies, over half-a-million tons of various food grains during the first three years of the war. But this favourable status rapidly deteriorated from October, 1942, when a devastating cyclone laid waste to four of the large surplus rice districts of Bengal, and extensively damaged communications on the East Coast as well. A partial failure of both monsoons in the province of Madras, further aggravated the situation. By this time, the country had become a main centre of supply, and a bulwark for operations both in the Middle East and in South East Asia. Service personnel and munitions of war were pouring in at all the Indian ports, chiefly from the United States under Lease Lend. All the railways, from which rolling stock had been withdrawn and despatched for use in the Middle East and the Persian Gulf, and in truth, all land and sea transport were working above capacity on service priorities. More arable land was

Discharging Bagged Wheat.

Indian Ports and Food Supply—continued

acquired for stores depots, vehicle parks, aerodromes and living accommodation for service men; for hospitals, and prohibited areas near the ports and beaches, for military exercises and lastly for security reasons. Many a ploughed field was taken over for these purposes, whilst the "denial" policy introduced on the East Coast and the nuisance air raids scared cultivators and workmen, thereby adversely affected the economic balance of the country.

In December, 1942, the Food Department of the Government of India came into being. The main problem was the one of procurement; the ancillary but equally important off-shoots of transportation, rationing, price control, growing more food, storage and distribution, had also to be put over the anvil. It was clear that a minimum of 1,000,000 tons of food grains would need to be imported every year, and that all exports out of the country, except for the services, should cease immediately. A reserve of half-a-million tons was also mooted, but remained a pious hope. Imports of wheat from America was now the main source of supply, as Australia owing to the Japanese incubus could not help with wheat or flour as she had done in the past.

Discharging Wheat Flour.

Barley and maize of rather poor quality was received occasionally from the Near East in small parcels. The shipping position being serious, supplies from America came in as a mere trickle, some bottoms bringing in part cargoes of one to four thousand tons. The target figure of a million tons in one year was never attained, just over half that quantity being the high water mark. A full load of eight to nine thousand tons of wheat like some that Australia sent out before and in the first two years of hostilities, was the exception in a whole year's shipments.

Discharge, Storage and Distribution of Wheat

It may be stated as a matter of information, that grain or seed is not handled or stored at any Indian port or town in bulk. Arrangement for bulk discharge, shipment or distribution have not been provided anywhere in India. The low cost of gunny and hessian and climatic conditions favour storage and shipment of grain and seed in gunny bags. An average daily discharge or shipment of four to five thousand tons of rice, grain or seed packed in bags, from one vessel, was quite normal in pre-war days. Special trained labour would however be employed in this work. Forty-eight hours sufficed to complete a straight cargo on a free working ship. For a vessel bringing in 9,000 tons of wheat in bulk, one or two of them would arrive in the fair season, a single-storied shed with good quay space was all-sufficient. Before she was berthed in dock, all port formalities were completed, and several hundred bundles of gunny bags brought in for bagging the grain, prior to removal by the consignee to his storage sheds near his flour mills, or railing some consignments to the larger towns in the country. Storage or rather "bagging bins," would be prepared on the wharf in line with the ship's hatches and the shed doors, by building up tiers of bagged wheat in a square. Into these bins the loose grain put out from the ship by seven or eight dock cranes in rope net slings lined with hessian, was unloaded, bagged and moved straight out of dock to the godowns or into rail waggons placed behind the shed. The vessel would work day and night and complete discharge in less than four days, and the dock shed, too, would be cleared in about the same time of all the wheat. Prior to the war, hardly 100,000 tons was imported in a year, and that through the four main ports, for economic rather than food reasons. This line of import was a mere trifle to the three to four million tons of rice, grain and seed imported and exported from the country all the year round. But from 1943, the position was reversed. Imports of wheat were the main consideration, all exports having dropped to a nominal figure and only for service personnel. The wheat, now so badly needed, arrived from America in small parcels, stored in half hatches of a "Liberty Ship" or at the bottom of her main holds. The grain would be discharged alongside and with the main service stores, and the residue put out a little later. The food department of the Indian Government, operating through the Provincial Director of Civil Supplies, had their own contractor for receiving the wheat on shore, bagging and despatching it out of dock. But whilst in the pre—or early war period, this cereal was almost completely cleared daily off the quay, now a large slice would remain in the sheds for some days, awaiting disposal instructions for various inland destinations, which included all the towns and large villages of the province and the adjoining districts and Indian states, some nearly 700 miles away. Neither discharge from the ship nor removal from the dock was anywhere as brisk as before; and as the contract was tendered for yearly, a new contractor had to get into his stride, sort out labour costs and other problems before he did an an efficient job of work. To expedite the filling of bags, wooden skids with pigeon hole shutters were fitted between the shed doorways facing the bins, and the bagging process speeded up in the bins and from the transit sheds as well.

A few months after the close of hostilities, whole shiploads of wheat, maize and flour began to arrive from Australia and America. The bountiful flow of the golden grain has steadily mounted, from a mere trickle to a lusty stream, with a message of hope, dispelling the hovering clouds of famine and scarcity, and giving that welcome silver lining to India's millions in their hour of need and adversity. India has been a bulwark in two World Wars—and did not fight in vain.

Swedish Engineers Visit Mersey Docks.

Six Swedish engineers, headed by Dr. Arne Bjornberg, the assistant principal secretary to the Swedish Board of Trade, recently toured Liverpool Docks. Dr. Bjornberg said they were interested in all descriptions of modern machanical appliances, and more particularly, in latest shed equipment and machines for the loading and discharging of cargo from steamers.